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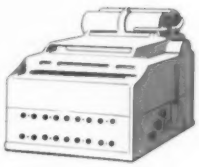

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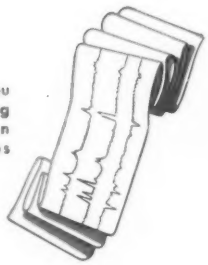

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Editorial Comment

LLOYD E. ELKINS
PETROLEUM BRANCH CHAIRMAN

A Preface to the Dues Referendum

IN A MONTH the Institute will begin a referendum of the membership on a proposal to raise the dues of Members and Associate Members to $20 annually (now $15), and those of Junior Members to $12 annually (now $10), to be effective with 1950 and to continue through 1951 and 1952, with the provision that in 1952 another referendum must be taken to determine whether the higher dues should continue.

Since this question has been at least tentatively explored in our publications and at our meetings over the past three years, and since all members must be aware of the operating deficits the Institute has incurred in each of these years, this announcement should not occasion any surprise.

The May issue of the *Journal* will carry in Section 2 a detailed explanation of the Institute's unsatisfactory financial position, including a recounting of those measures, short of a raise in dues, which have been taken to improve this position. Our editorial columns in the May issue will show why the Petroleum Branch Executive Committee recommends the raise in dues, with a complete review of the developments responsible for this attitude. This position will be supported by an income and expense statement reflecting the status of each Branch for the first quarter of 1949 and extrapolated for the entire fiscal year.

We believe that every reasonable possibility of averting a raise in dues has been given complete consideration, and that every petroleum member of the AIME may vote to approve it with confidence that his elected representatives have taken every measure for the protection of his interests.

Much of the successful opposition to a raise in dues in 1945 came from petroleum members. Since then the Petroleum Branch has expressed more concern over the Institute's procedures and financial position than any other technical group, and has argued most strenuously for alterations in administration viewpoint and membership services. Part of our objection to an increase in dues has been removed by the increased progressivism of the Board, and the rest has been stifled by the drastic rise in the cost of staying in business.

Since we have long been militant for AIME progress, it is not to be expected that we are without ideas for application during the coming three years that will, we hope, make it possible to revert to the lower dues level in 1953. These ideas will be presented in the May *Journal* with our final recommendation that you vote "Yes" on the coming referendum.

Petroleum Branch to Participate in Columbus Ohio Regional Meeting

Decision has been made by the Branch Executive Committee to hold a petroleum program in conjunction with the Institute's 1949 Regional Meeting, which is to be held in Columbus, Ohio, at Neil House (Hotel) on September 25-28. The petroleum program will consist of two days devoted to technology and economics slanted toward the interests of our many members residing in the Midwestern, Appalachian and Eastern areas. These annual regional meetings are in the nature of an Institute Annual Meeting on a less elaborate scale and feature the program participation of nearly all of the major technical divisions of the AIME, as well as an official meeting of the Board of Directors and sometimes of the Local Section Delegates. The Petroleum Branch customarily participates if the meeting is well situated with respect to a sizable portion of the petroleum membership; as in Houston in 1944 and Denver in 1947.

R. W. FRENCH, JR.

R. W. French, Jr., vice-president of Sohio Petroleum Co., Cleveland, will serve as general chairman for the petroleum portion of the meeting. The program is being assembled with the advice and assistance of a number of members prominent in the locale of the meeting, and will attract attendance by a great number of Branch members who have been unable to take part in any of our previous large meetings.

Calendar of Major AIME Petroleum Branch Meetings in 1949

April 27 — Joint Meeting, Oklahoma City and Mid-Continent Sections, Campus, University of Oklahoma, Norman.
Sept. 25-28— AIME Regional Meeting, Neil House, Columbus, Ohio.
Oct. 5-7 Petroleum Branch Fall Meeting, Plaza Hotel, San Antonio, Texas.
Oct. 20-21 — Petroleum Branch Fall Meeting, Elks Club, Los Angeles, California.

CURRENT STATUS :

Petroleum Branch Publications

Stocks on some volumes of the reprinted petroleum Transactions are becoming so low that those members who have any intention of ordering should do so very soon. Inventory as of going to press was:

1946	Nil
1944-45	Nil
1942-43	9 copies
1940-41	60 copies
1938-39	54 copies
1936-37	94 copies

Student Associates and other members may secure the books for $6.50 down and $6.50 per month. These books should be ordered from the Dallas office. The 1947 and 1948 petroleum Transactions volumes (original editions) should be ordered direct from AIME, 29 West 39th St., New York 18, but these stocks are also low, so orders should be prompt.

The 1949 petroleum Transactions volume, which contains the papers published in the 1948 issues of "Petroleum Technology" will soon go on the press in the East, and may be available in late summer. This will be the last Transactions volume in the 6" x 9" page size. The 1950 Transactions volume will contain the papers published in the 1949 issues of the JOURNAL OF PETROLEUM TECHNOLOGY and will come to you in January, 1950, with pages the size of the one you are now reading.

The 1949 STATISTICS OF OIL & GAS DEVELOPMENT AND PRODUCTION, containing reports on 1948 worldwide exploration-drilling-production activity, is going to the printer as manuscripts come in. Our objective date of issue, which is almost entirely dependent on date of receipt of the various reports, is June, of this year.

If you are not positive that your last publications selection sent to the Institute's New York office reflected your desires as to receipt of any forthcoming volumes, we suggest that you write in to be sure.

Since the last publications selection sheet sent to you was complicated by the change in publications, a resume of the rules may interest you.

Junior Members, Members and Associate Members may receive one of the three monthly magazines at no charge in addition to dues. Subscription to more than one magazine costs $4 per added subscription. Receipt of the 1949 and 1950 Transactions volumes is optional with the member, and each costs $3.00 in addition to the dues. The Statistics volume is free to those subscribers to JOURNAL OF PETROLEUM TECHNOLOGY who have indicated in advance of its printing that they wish to receive it. There will be no AIME Directory printed for 1949. In lieu thereof the Petroleum Branch will publish a roster of those who were Branch members at April 1, 1949. There will be no charge for this roster, which will be issued in June.

Petroleum Branch Executive Committee Open Meeting

SAN FRANCISCO, FEBRUARY 17, 1949

EDITOR'S COMMENT: *The following is a condensation of the minutes from this meeting. The comments which were deleted would not assist the membership in understanding the problems discussed or in drawing conclusions about them, and are not carried because of space limitations.*

Treasurer's Report

CHAIRMAN ELKINS: Item 1 on the Agenda is recommendations of I. W. Alcorn, outgoing chairman. We will hold that in abeyance until the latter part of the meeting, as a lot of his ideas will be brought out in discussing some of the other items.

The second item, the Treasurer's Report, is attached. There are three key figures in the report. We have in our Special Projects Fund, and our Publications Fund a total cash sum as of January 31 of $10,209.84. Adding that to the liquidatable assets in the books and our addressograph machine, we have a total asset value of $16,707.02, in cash or items convertible to cash. The cash portion of these funds has been increased $4,417.91 over January 1, 1948.

If there are no questions or objections, I will instruct our Secretary to file the report as accepted.

Meetings and Meeting Chairmen

The next item concerns the announcement of meetings for 1949, and the general chairman appointed for these meetings. The General Chairman will be:

Harold Decker, Vice President, Pan American Production and Gas Co., Houston, for the San Antonio meeting, Plaza Hotel, Oct. 5, 6, 7.;

John Thatcher, Jr., Southern Division Mgr., Standard Oil Co. (Calif.), for the Los Angeles meeting, Elk's Club, Oct. 20-21;

R. W. French, Jr., Vice President, Sohio Pet. Co., Cleveland, for the AIME Regional meeting at Columbus, Ohio, Neil House, Sept. 25-28;

Gail Moulton, Chase National Bank, New York, for the 1950 AIME Annual meeting, Feb. 12-16, Pennsylvania Hotel, New York City.

These appointments have all been concurred in by the Executive Committee prior to this meeting.

Nominating Committee

The next item concerns the appointment of a committee to nominate Branch officers for 1950. I circularized the Executive Committee in advance of this meeting concerning five appointees and have been authorized to announce the following personnel for the Nominating Committee:

I. W. Alcorn, Houston, Texas, Chairman;
Basil Kantzer, Los Angeles, Calif.;
James Posgate, New Orleans, La.;
John Hammond, Tulsa, Okla.;
Charles Pishny, Fort Worth, Texas.

The Journal

The next item concerns the *Journal of Petroleum Technology*. It was placed upon the Agenda to invite criticism, suggestions, and any questions you might have.

When this agenda was prepared we had contracted for $15,000 worth of advertising this year, and our budget has been set up on the basis of $20,000. Such solicitation as we have been able to make had to be done after prospective advertisers had set up their budgets, and before they had a chance to see what our magazine would really look like. It is anticipated that $15,000 will be expanded to more than $20,000 before the year is over and come close to our budget estimate in that respect. Are there any questions about the *Journal?*

MR. ANDREWS: With reference to your contemplated means of soliciting—

CHAIRMAN ELKINS: The Secretary will explain.

MR. STRANG: The plan for solicitation as it stands now is that the members of the Dallas staff, Mr. Alford and myself, will, as we travel, contact potential advertisers; that from the Dallas office we will put on promotional campaigns consisting of direct mailing and liberal use of telephone and personal letters and other devices handy; that we ourselves, will attempt to handle our own advertising solicitation entirely, pending more experience in the matter.

The Editorial Board has had placed before it the applications of two or three publisher's representatives in various parts of the country. For instance, on the Pacific Coast, a Mr. MacDonald in San Francisco would like to handle our California business for a percentage. There is also a standard agency deduction of fifteen per cent. That leaves us so little, after the agencies have been paid, that at the moment, the hiring of publisher's representatives is not attractive. Moreover, it is customary in such agreements to give the man a percentage on business secured from within his region by

anyone, and to give him a percentage on renewals of all business, no matter who originally made the solicitation and secured the contract.

CHAIRMAN ELKINS: I would like to mention in that repect that near the close of the Board meeting the other day, the Chairman of the Metals Branch moved to the Board that they follow through on the Johnson Committee report and employ an Institute advertising manager. I objected to that on the point that the Petroleum Branch was in a position to handle their own advertising, and the Mining Branch were handling theirs, although they are handling it by a man who is right now in the Institute headquarters, and suggested they consider the alternative method of a publisher's representative to do the job within the Metals Branch. The point is, we are going to insist, and I think the Board is in sympathy with our viewpoint in that respect—at least at the moment they are—that whatever advertising promotion is done be done within the Branches and directly charged to that Branch accordingly, just like ours will be charged to us.

MR. MOULTON: It occurs to me that in view of the large annual expenditures in the field with which we are concerned, running to several hundred million dollars, our objective of $20,000 per year for advertising in our own *Journal*, which I think will be recognized as one of the better advertising mediums, is a very modest fraction. Our $20,000 will be a very modest part of the income equipment and service companies could expect to derive from promoting sale of services and material through the *Journal*.

CHAIRMAN ELKINS: I think the $20,000 set up this year was purely on the assumption that we didn't have any running start at it and hope to build it up.

MR. PYLE: I think it would be a mistake for members of the Petroleum Branch to go out and solicit advertising until the normal procedure of soliciting it has been tried. We would all be working at cross purposes and with inadequate facts and figures on circulation and cost and requirements. It seems to me that members of the Branch could well come to the help of the normal solicitors of advertising—if they find that they are not making headway with a supplier we think should advertise in our magazine. Let's don't go off in all directions to start with, because you haven't had many months, and I think you have done an excellent job to have as large a commitment on advertising as you have.

MR. ANDREWS: My interpretation of the remark is that it would be a matter of letting the advertisers know they are interested in seeing his stuff in the magazine. That would be a big help.

MR. STRANG: I'd like to say that Mr. Pyle's conception of how the membership can best help is exactly my own. Assistance in specific cases for particular reasons would be a wonderful thing, but for the most part, the best help the membership can render is just as a matter of mentioning at every possible plausible opportunity that you think it is a good magazine and well read by the petroleum engineers, with no disclosure of intent to secure anybody's advertising in particular.

MR. BETHANCOURT: It is also very possible when you are talking to some of the gentlemen in these various companies for you to observe that "I haven't noticed any advertising from your company."

CHAIRMAN ELKINS: In a nice, friendly way. In other words, you have to do it in an informal way.

MR. BETHANCOURT: I think that will bring more results.

MR. STRANG: When a representative of a service or equipment company enters your office, you could be reading the *Journal*.

MR. BUCKLEY: Reading somebody else's ad, though.

CHAIRMAN ELKINS: Collectively, we have got the solution. Are there any other comments about the Journal?

MR. PYLE: What we want are some satisfied advertisers that will put a full page in and leave it there for ten years or twenty years. Just making an advertiser feel that he has been squeezed into subscribing to something isn't the full answer. It is to get someone that wants to throw his lot in with the magazine and stay with it. That is the reason we don't want to go to an agency, because we think we can have low cost of soliciting this advertising, but there ought to be a lot of well accepted, solid suppliers that will, every month, year after year, carry advertising in it. I think that is the kind that, even if it takes longer to get them, will add a stability to the publication that we would like to see.

MR. BUCKLEY: I think that point is very important, and that if this *Journal* is to succeed, it is going to have to succeed on its own merits. Advertising ought to be sold on the merit of the *Journal* as an advertising medium. Although we might put pressure on the temporary advertiser, in the long run it won't do us any good. I think we ought to be careful about pressuring people into carrying an ad six times a year, or anything like that. If we will go about it more slowly and sell the thing as a proper advertising medium for a particular type of advertising, solely on its merits, in the long run we will be ahead. I think the discussion that has preceded this is just the atmosphere to make these prospective advertisers aware of the fact that the people in the industry do read the *Journal*.

CHAIRMAN ELKINS: Are there any other discussions on the various aspects of the *Journal?*

Roster of Petroleum Members

MR. BETHANCOURT: I wonder if there would be any possibility of attaching a roster of our members to one of the issues?

MR. STRANG: It is only a matter of money. If we want to spend the money, we can include a roster of our members.

MR. BETHANCOURT: Could you give a rough idea of what it would cost to attach it?

MR. STRANG: $650 to $1,250, for a roster of the Petroleum members, is what it would cost us.

MR. BETHANCOURT: I think it would lend considerable strength to the Petroleum Branch to publish such a roster.

CHAIRMAN ELKINS: Would you want it listed by cities and sections, or what?

MR. BETHANCOURT: I think an alphabetical and city list would be ample.

CHAIRMAN ELKINS: I would like to entertain a motion in that we publish such a roster.

MR. PYLE: What will this do to the Institute's roster? If we provide one for the Petroleum Branch, that will lessen the demand at $1.00 a copy for the Institute's publication.

MR. STRANG: They do not plan to print a Directory in 1949, so that other portions of the Institute won't be receiving anything in the way of a list of their members.

MR. PYLE: Then I vote twice in favor of it.

MR. BUCKLEY: I would like to ask a question. As I understand it now, we are uncertain as to who are Petroleum Branch members, because they haven't mailed in cards to New York. I wonder if this condition will be straightened out soon enough to make a Directory.

MR. STRANG: I think the problem you mention is due to a lag in getting members included in the stencil system after the check is received. This applies mostly to the first-of-the-year rush, and should not be a complicating factor after April 1. The list we then get from New York may have another fault in that they carry the man in the wrong town or perhaps with the wrong company. We can eliminate this defect by sending everybody the card that we get from New York with an announcement that tells them of our intentions and provides them with a form on which they fill in personal data exactly as they would like to have it appear in the Directory. We can have the printer set type from the cards the members turn in, so if there are any errors, they can be attributed to the source, provided they are not typographical errors.

MR. BUCKLEY: Mr. Chairman, I move that the Branch office in Dallas be authorized to prepare and issue a directory as a separate part of one of the monthly issues of the *Journal* as early as is feasible in 1949, and that the cost of this be paid out of the Special Projects Fund of the Petroleum Branch.

. . . The motion was seconded, voted and carried . . .

MR. BUCKLEY: In regard to this Directory matter, I think there might be another step taken. There was a great reluctance on the part of those present at the Board meeting the other day to abandon a Directory even for the year 1949, and they all seemed to feel much as we do—that they needed it, but didn't have the $12,000 and couldn't afford it. One of the things we are trying to do is to show the Institute how to reduce expenses and streamline the organization, and if the Petroleum Branch with its own funds can give the membership a Directory that might be called to the attention of other branches, it might be feasible for each Branch to prepare their own Directory. Then all those could be clipped together as an All-Institute Directory, and include, perhaps, by-laws with it. That way it might be possible for the Institute to have a Directory annually, earlier than we have been used to in the past, and that perhaps, at no net cost or a very low net cost to the Institute as a whole, instead of something that costs around a dollar per member. It might be a step by which we could point the way.

CHAIRMAN ELKINS: That is well put, and we will have an accurate cost on this deal. When that comes up next year, we will be able to follow through as you suggested. That is the best way to convince the Board of something—show them it is actually being done some way. Is there any other discussion?

Transactions Reprinting

MR. PYLE: Before you get off on another subject, I would like to say that I think we should comment favorably here on the outcome of the reprinting of the Transactions. I think we ought to acknowledge the excellence with which the job was handled, the financial success of the project, and acknowledge the feeling of general satisfaction that we have made these publications, which have been so scarce, available to the membership and others.

CHAIRMAN ELKINS: In case all of you haven't read it, after paying out all costs, there is, including the inventory of books, and accounts receivable, a net value of the fund of $7,100.00, and in addition, there is the good will that has been passed on to younger members who have a chance to buy up the past publications.

Publication of Bibliography

MR. HAMMOND: Before we leave this, I would like to bring up something for just a suggestion, not to be decided here. I believe there are some bibliographies available on petroleum Transactions during the past years that are relatively complete. I would like to suggest your group consider publication of a current bibliography to help the members by having in one spot reference to all previous technical papers.

MR. SHERBORNE: You mean a comprehensive index of what has been in it during the past year?

CHAIRMAN ELKINS: Do you mean "year" or "years"? How far back do you propose to go?

MR. HAMMOND: To the beginning.

MR. STRANG: It was an Institute practice to issue every ten years an index or bibliography, I believe. The last one covered up to 1934 or 1935, so we could bring it forward from that point.

MR. HAMMOND: You mean including what was published in 1935?

MR. STRANG: Not including anything published prior to the last Institute index.

CHAIRMAN ELKINS: I think that is something that has to be checked into. Is there any other suggestion on that point?

MR. SHERBORNE: I think that is something that could be handled by a committe appointed to do the compilation work. That would be a job in itself.

CHAIRMAN ELKINS: What is your wish? Do you want to appoint a committee and get into this?

MR. UMPLEBY: There is one thing I would like to suggest. I am amazed at the amount of detail that goes through the Dallas office. I think we have got a lot of things down there to digest and get to working smoothly, and an additional job of this sort ought to be delayed for a year or so. Let them consolidate their work first.

MR. BETHANCOURT: Why don't you wait until 1950 and make it a ten-year stretch, and plan for something like that.

CHAIRMAN ELKINS: Those are good points. I want to find out the will of the group.

MR. BUCKLEY: We could do the job in 1950 and every ten years thereafter.

CHAIRMAN ELKINS: That is a good suggestion. Is there any other discussion on that point, or any other action? Does anybody wish to make a motion?

MR. BUCKLEY: I move that the Chairman appoint a committee to investigate the feasibility of publishing a comprehensive bibliography of papers published in the Petroleum Transactions of the Institute, publishing such bibliography in 1950 and every ten years thereafter.

. . . Motion seconded, voted and carried . . .

Advance Mailing of Preprints

CHAIRMAN ELKINS: We will proceed to the next item on the agenda which is the discussion of the proposal for advance mailing of Fall Meeting preprints. Mr. Strang has conducted a poll and is prepared to brief this group on the results of that poll.

The Secretary then read a tabulation showing the results of questionaires sent out to determine the apparent popularity and feasibility of a plan for mailing out preprints in advance of the meetings; the purpose being to do away with the need for lengthy presentations from the authors and to secure more pertinent discussion at the meetings. The replies indicated that most members would favor such a system, would pay for preprints in advance, and would not anticipate any personal or corporate reactions that would decrease the attendance at the meetings. A financial hypothesis based on the questionaires indicated that the plan could be applied without loss of money, although certain optimistic assumptions had to be made as to timing and author's provision of some of the preprints. A lengthy discussion ensued, touching on the practices of other societies, the difficulties to be met by the program committees, existing methods of securing discussion, author's reactions, etc. In view of the quantity of other new plans and practices now being put into effect by the Branch, the committee tabled the proposition for discussion at a later meeting.

Accounting

CHAIRMAN ELKINS: "Other Topics as Desired by Committee or by Members in Attendance" is next on the agenda. I would like to interject two topics of my own to clear the record. One is a carry-over from the Executive Committee Meeting in Dallas in October wherein Mr. Strang was requested to investigate the feasibility of setting up an accounting system in Dallas that would reflect all activities of the Branch. The report was mailed to the last year's and this year's Executive Committee which in substance was prepared and presented to Mr. Strang and myself by the firm of Barrow, Wade, Guthrie & Co., and in essence they say, "You can't do it in Dallas." We will keep the present system of journalizing Branch-controlled accounts there. It is in perfect order as attested to. There is only one way to change the basic accounting system, and that is to start at the central point. So, they recommended no further action in that respect. I think that constitutes a report in answer to the question of the Executive Committee in October. Since the Branches have been set up, the Finance Committee has planned to set up their accounts and budgets on a Branch basis. I think the central accounting system in New York, as it is streamlined and defined, will adequately provide us the control data that we need to put our finger on our own economics.

Democratization of the Institute

One other item that I would like to mention is the fact that some of you who were in the Board of Directors meeting Tuesday heard the Report on Democratization of the Institute. There are two items the National Board are going to act on, I presume, in the March or April meeting, both of which affect vitally, I think, the economy of the Petroleum Branch, or any other Branch.

One is that they propose that the New York secretary spend about 40 per cent of his time traveling around to all the sections. That would increase the New York overhead by $6,000 over what it is now, directly in traveling expenses. Then, in order to permit him to travel forty per cent of the time, they would have to hire another under-secretary, which would increase the overhead another $5,000 or $7,000. I am going to be in a position to vote on that, and what I would like to know from this group is: Do you think that the traveling of the New York Secretary around to all the Sections—not to the Branches, now, but down to the Sections—and meeting the people at the membership level is a step in the right direction?

MR. BETHANCOURT: I think it would be a waste of money. If we are going to do anything like that, let's have our own Secretary do it.

MR. ATKINSON: I am afraid you can't do that simply because all areas are not all petroleum. Certainly, one of our criticisms of New York was that the secretary did not know what the working engineer wanted, and only represented the Board of Directors' viewpoint, and that someone—call him what you want—from the New York office must get in closer touch with the working member.

CHAIRMAN ELKINS: Is that worth a dollar a year to you?

MR. ATKINSON: I think that it must be worth that to keep the Institute together. If that isn't the general intent that the Petroleum Branch has been working on, and we have said that it has for years, then we are perfectly correct in saying the only thing we want for our personal contact is the Petroleum Secretary. But I believe we have all pretty much agreed that we want to expand and strengthen the Petroleum Branch through the national affiliation. To answer your question specifically: Yes, I think that is worth a dollar for the New York office to know what the working engineer is thinking.

MR. BUCKLEY: May I ask you a question in that connection? I haven't been able to clear up the mechanics by which a Secretary visiting the local section meets the working engineer you refer to. Does he call the directors of the Local Sections to have lunch with him, or does he actually meet the membership, and if he does, through what sort of set-up does he actually get to talk to them?

MR. ATKINSON: Mr. Parsons tried that last year, or maybe the year before. He attended a meeting. He spent five or six days in Los Angeles. He met with many small groups. I know that various working engineers talked to him on the job. They thought it was worthwhile. Out of nine

hundred, I would imagine that he probably directly talked to a hundred and fifty. I think that is a pretty good average. I think it would largely depend on the man. I think if a Secretary from New York actually got the feeling of a sampling out of nine hundred in the Southern California area once a year, he would certainly represent their views much better than they had been represented in the past.

MR. SHERBORNE: That is a point I am interested in. As far as I can recall, the Secretary has had an opportunity once a year to do that in the past. Is it understood that is going to be changed, and that the Secretary is not going to come to the meetings?

MR. ATKINSON: He hasn't had that opportunity. The experience in the past five or six years has been that he arrived, attended luncheons with the big shots, and took the next train out.

MR. ALCORN: I may have a little different approach to it, but I can't see how such a traveling Secretary would be very effective. I think the problem of acquainting the policy-making body of the Institute with membership opinion depends upon the organizational set up of that body. It is very easy for the Chairmen of the three Branches to advise the policy-making body, while having some one individual running around over the country to accomplish the same thing would be more apt to confuse the issue.

I think the real solution to getting a better understanding is in creating a setup which wouldn't rely upon an individual at all. My idea of a solution ties in with the proposal to reduce the number of Board meetings and to have them in different areas, and to have a reduction of the number of Board members; have a smaller compact group that understands the detailed problems of the groups they represent. I think that would be the way to achieve it.

MR. UMPLEBY: I think this thing goes back long before the beginning of the Petroleum Branch. There has been a tendency, rather inherent in the setup, for New York to tell the members what they want, rather than for the members to tell New York what they should do.

This move is an effort to correct that situation. I would rather hesitate to discourage any move in that direction. I don't quite like the picture as presented by the Committee on Democratization, but they are working on a thing that has been a historical, fundamental thing, and I would hesitate to take too strong a position that might cramp their style in approaching that deep-seated problem. My feeling would be not to take too strong a position. Try to help work it out.

MR. V. C. SMITH: I hate to talk too much, but I don't believe the reason for the suggestion has been properly stated. The fundamental idea, stated tersely, is to bring the Institute as a whole closer together, to bring all the Branches closer together. I don't think this is an attempt on the part of the Eastern or New York group to tell you what you should do. It is, rather, to point out to you that you are still members of the AIME as a whole, that Metals and Minerals Beneficiation are a part of this Institute, and that in certain fields, we have a common interest.

CHAIRMAN ELKINS: My thought in this respect is simply that I agree with you wholeheartedly that there is a motive to keep the Branches tied together, to the point that they are recognized as one common group. My thought was the whole thing could be accomplished within our structure by planning definitely that the Executive Secretary meet with the Branch councils of these three or four Branches quite often, and get the pulse of things at that level, rather than try to expand clear out all over the country.

MR. V. C. SMITH: I think they attempted to do this the expensive way, and again put money in New York. New York doesn't need it. The fundamental premise is sound; but as far as the projected financing is concerned, I think it a bit ridiculous. That is a personal expression.

MR. CLARK: In Southern California, we have a different problem than most Sections in that we have a Section that is composed of all the Divisions, all the Branches. We have very little contact with New York. When Mr. Parsons came out, Mr. Atkinson took him all over the area, spending two or three days at it, and he did a good job. I think that there are certain types of Sections throughout the country that will have to have that type of contact. Other Sections containing members of one Branch only may get the necessary contact from the Branch headquarters. For the more complex Sections we are going to have to have some sort of contact with the Institute, and I think the Secretary is the only way you can get it. As far as the Directors are concerned, they have specialized interests also, and it is rather difficult for them to get out and meet the men on a working level.

MR. ARTHUR: I think there might be some advantage to a traveling Secretary meeting the members, but I don't think that it is necessarily the only way to make the New York people aware of what the membership wants. I think this can be done in a much more economical way.

MR. BUCKLEY: I think we all agree in principle on what we want here. I think the big question is one of what is a sound democratic organizational procedure. We can go through two routes. Our Sections are organized and our Branches are organized. One route would be to go through the representatives of those Sections, those Branches, who can speak to the engineers at the working level and get the viewpoint of their people and transmit that viewpoint directly to the Board for action at the Annual Meetings or any other meetings. That would seem a direct and democratic procedure where you are being represented through elected representatives.

The other is where you give your views to a Secretary who in turn is expected to interpret and transmit your views to a Board. It is really an entirely different procedure, and there is room for slip-up. It is not effective to transmit views to an acting body that is going to make decisions through a third party who is not familiar at first hand with the problems you have been discussing and worrying about at the local level. For that reason, I think the proposal is fundamentally unsound in principle. I think what it amounts to is a lot of traveling and glad-handing, which may help to keep people acquainted with who the New York people are. I don't see, as a practical matter, how that procedure can produce useful results, and I think the tendency will be for you to expect the Secretary to get things done instead of expecting your own officers of the Sections and Branches to get things done.

I am afraid that such a step will let us slip back into something where we are dependent on the Secretary. The Direc-

tors, when they meet, generally have only a day, or a few hours, in which to transact business. It is easier for them if someone has written out ahead of time the expected action, so they can run hurriedly through without discussion. I think a lot of action or lack of action has been a matter of default in that busy people with limited time can't go thoroughly into each question. If you are going to rely on a Secretary who prepares an agenda before the meeting and has your views in the back of his mind, but has listened to lots of different views, it is excusable that he may get confused sometimes. I don't see how you can possibly get the same sort of direct action you can get when you have something important you want acted upon or something important you don't want acted on, and can tell the Directors themselves that the matter is important to his Local Section or important to his Branch, and his people want action on it. It is a lot different with many talking and somebody saying "I talked to those people, and I think they want thus and so," and for that reason I think we ought to go very slowly in giving support to this recommendation.

MR. ANDREWS: I think that is a clear statement. I think it is fundamental to the organization. We might look at it historically with reference to comment made here as to the interpretation of the good done by a Secretary making such tours as have been proposed. Such a tour was made, and certainly the man involved got quite an earful, but his conception of what the membership wanted was a factor in the termination of his service with the Institute.

I believe the national Secretary can be best informed through the organizational mechanism that we have. The members express their views to the Chairman of the Local Sections. These views work on up through the various Branches to the Executive Committee and Chairmen of those Branches. The Branch Chairmen have the opportunity to advise the Secretary what his people are thinking. There couldn't be a better way of informing the Secretary or whoever is responsible for the ultimate continuity.

CHAIRMAN ELKINS: I think we are all thinking in the same direction, and unless there are any other pertinent remarks, I would like to close the discussion on this, and proceed to the rest of the agenda.

New Orleans Invites

MR. DUNLAP: I hope it is not too early to bring up the question of the location of the Mid-Continent 1950 Branch Fall Meeting. In behalf of the Delta Section I would like at this time to tender an invitation to the Petroleum Branch to hold its 1950 Mid-Continent meeting in New Orleans.

CHAIRMAN ELKINS: Are there any other invitations? Thank you, Mr. Dunlap. I don't think that can be decided today, but I know that unless the Executive Committee has a different idea on the thing, we will have to have Mr. Strang check the hotel situation and see whether we can get the proper hotel reservations lined up.

MR. DUNLAP: We have made a brief survey of the hotel situation, and think it has improved considerably during the last several months. Our organization is more grown-up now. We are three years old, and we think in recognition of our growing oil industry down there and unusual and interesting operating conditions, we have reached the stage now where we might be in line for the meeting, and would like to have the Executive Committee consider us.

CHAIRMAN ELKINS: Is there any other discussion on that point? There is just one thing I had in mind, before we officially decide one way or the other, and that is the fact that there is a possible conflict in New Orleans with the A.S.M.E. who are scheduling a meeting. It might not be a conflict, but they have tentatively scheduled a meeting there in 1950, and some of the group wants to hold it the same week that we hold ours. That is, one person does, anyway, and some of the officers want to hold it at a different time. We will have to check into that. We don't want to hurt ourselves—or them either, as far as that is concerned—by selecting it until after that has been thoroughly reviewed. If there is no objection, then, we will instruct our secretary, Mr. Strang, to get together with Mr. Dunlap and check into that situation and advise the Executive Committee as to the hotel situation. We can settle it by mail. I know of no other invitations, and possibly there will not be any others.

Referendum on Dues Raise

CHAIRMAN ELKINS: If there are no questions, I would like to make one closing observation, and that is that most of you are aware, probably that some time during this year you will be contacted by referendum for increase in dues, $5.00 per Member, and $2.00 per Junior Member, for three years, 1950, 1951, and 1952, with the stipulation that following that, further referendum will have to be submitted to the membership as to what the dues should be thereafter.

The delegates voted a two-thirds, or almost three-fourths, majority vote in favor of that action. Our Executive Committee, without officially taking action on it, have accepted it as the only way to get us out of the difficult financial straits now, and give us time to organize, consolidate, and streamline our organization from New York clear down, so that we can increase our advertising income and try to get our budget arranged to where we might be able to go back to $15.00.

It is simply this: We cannot fail to get the majority vote on this referendum. No matter what we do this year, the Institute as a whole is going to operate on a deficit of about $56,000. If the membership are uninformed and misinformed and would vote down this increase in dues on that set-up, I don't know what in the world the Board of Directors could do.

Through the *Journal*, our Executive Committee is going to inform, and try to sell, and sincerely sell, the petroleum membership on this program, and give them the reason why we have to do it, and what we hope to learn during the three year period, so that whatever the answer comes out by 1952, we will know where we stand.

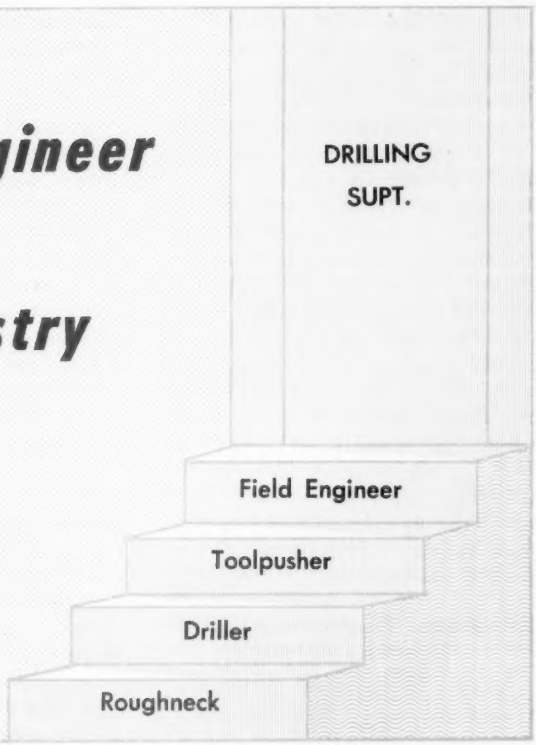
We have been fighting it all this time, primarily because we didn't know exactly where our money was going, and couldn't find out. We can find out, now, and will find out during the next three years.

I wish I could deliver this thought to 4,000 members instead of a handful, but it is up to us, whatever we do, to throw the psychology in that direction. I think that is the feeling of our Executive Committee.

Whereupon the meeting adjourned.

The Place of the Engineer In The Drilling Industry

By
George P. Livermore
George P. Livermore Inc.
Lubbock, Texas



This year it is estimated that the oil industry will spend two billion 935 million 846 thousand dollars[1] for the drilling and producing of oil. In the United States today we are producing an average of 5 million 500 thousand barrels of oil per day. This year the production department, in order to produce the oil, will spend 620 million dollars. For the drilling of new wells in proven fields and for wildcat and exploratory wells the drilling industry will spend 2⅓ billion dollars. This means that of all of the money spent by oil companies for the drilling, development and producing of oil this year, 37½% will be spent in the production department and 62½% will be spent in the drilling department. There will be drilled a hundred thirty-six million feet of new hole with an average cost per foot of $21.10. This cost being divided into wildcat costs of $28.35 per foot of hole drilled and a development expenditure for producing wells of $11.90 per foot of hole drilled. Of this approximately 3 billion dollars that will be spent for the drilling and producing of oil, better than 50% will be spent under the direct supervision of the drilling contractor or company drilling department for such things as labor, bits, mud, fuel, water, drilling supplies, etc. This figure, however, does not include such things as acidizing, cementing, casing, tubing, pumping, equipment, etc., which are included in the overall picture. The overall average cost per well this year will be $57,500.00 per well. The average cost per wildcat drilled will be in excess of $100,000 per well.

On December 1 of this year there were approximately 3600 drilling rigs in operation in the U. S. Of this number 2410 were rotary drilling rigs and the balance of 1200 were cable tool rigs.[2] It is estimated that we will drill over 40,000 wells this year. Of all these wells drilled in the United States, 82% are drilled by independent drilling contractors, and 18% are drilled by company owned tools. Another thing to keep in mind in analyzing the importance of this industry is that for every 1000 barrels of oil produced, we of the drilling industry must drill 64 feet of hole if we are to maintain our current production. With the amount of money being spent, and the size of this industry, it is amazing to note the scarcity of engineers employed. We undoubtedly have the questionable distinction of being the largest mechanical industry in our modern economy employing the fewest number of engineers.

This does not mean that there has been no engineering work done, but the preponderance of engineering that has been done has been done by the firms manufacturing and selling equipment to the drilling contractors, and the drilling departments, and in this field these people have done an excellent job. Nevertheless, the need for engineering does not end there, but the use of engineering to all practical purposes does. Drilling

Manuscript received in Petroleum Branch Office December 4, 1948. Paper presented at AIME Meeting, University of Texas, December 16-17, 1948.

[1] Report of Standards Committee — 19th Meeting of I.P.A.A.

[2] Brad Mills, Executive Vice-President, American Association of Oilwell Drilling Contractors.

operations and methods have developed as a highly specialized and highly exclusive field over the last 30 years, with the general result that the men in the higher positions in this field have almost invariably come up from the roustabout and roughneck level, and due to the highly specialized and peculiar requirements of this industry, such men have been forced to develop and carry the technical load, unassisted by technically trained graduate engineers. This is in part due to our industry failing to recognize the value and the need of such trained engineers, and it is partially due to the failure of our universities to offer the proper combination of specialized courses that would fit an engineer for work in this industry. However, the universities cannot be expected to recognize the need if the industry remains silent and does not ask for men of these peculiar qualifications.

Educational Requirements for a Drilling Engineer

It might be appropriate at this point to set forth some of the educational requirements of an engineer planning to go into the drilling industry. He should, of course, have a thorough grounding in the fundamentals of engineering which include mathematics, physics, mechanics, hydraulics, thermodynamics, chemistry, English, etc. In addition to these fundamental courses that are necessary to any engineer, a man preparing himself for work in this industry should, in addition, have specialized courses directed primarily at the problems to be encountered in the technology of the operations of the drilling industry. Such specialized course should include sufficient geology to make him conversant with the work of the geologist on the well. It should include sufficient reservoir engineering to permit him to understand the problems of the reservoir engineer and to prepare him to properly and intelligently handle completion problems and understand the importance of early information obtained at the time of completion of the well. He should have sufficient work in production engineering to permit him to be conversant with, and intelligently handle, any problem related to the equipping of the well after completion. He should have a firm grounding in mechanical engineering courses relating to power generating and transmission equipment, for a drilling rig is above all things a power plant of some complexity. He should have a good knowledge of machine and power equipment design as a prerequisite to a proper understanding of the operation and maintenance of the drilling equipment. He should have a good working knowledge of electrical engineering, particularly in the power phases because in many areas this is and will continue to be an important power source. He should have a thorough grounding in the chemistry of drilling mud, an understanding of the various well logging methods, and a good working knowledge of general and cost accounting for obvious reasons.

If these are the curricular requirements of an engineer for the drilling industry, it may furnish a partial answer to the question of why there are so few engineers in this field. Because such a curriculum is entirely unique and in no manner similar to any engineering curriculum now being offered in any engineering school. The usual petroleum engineering course does not supply these needs, nor does the usual mechanical engineering course, and obviously electrical engineering nor any of the others even approach it. With these requirements in mind it should now be obvious that the universities are in fact not offering the combination of courses that would fit an engineer to this industry. Although at present the universities are not offering special courses of training for drilling engineers, it is realized that a well-trained petroleum or mechanical engineer with the proper subsequent field experience is capable of making an excellent man in this position. I hope that such a course will soon be offered in some of our universities with a degree in petroleum engineering, drilling optional.

Field Experience Necessary

Thus far we have talked about universities training engineers for the drilling industry, but it would seem in order now to point out that the universities cannot, and we of the drilling industry do not expect them to, supply us with finished engineers. In this respect the drilling industry is no different from any other industry employing engineers, and we realize that our industries must share the burden of the universities in training a man to the level on which he can correctly and justifiably be classed as an engineer. We realize that there are two phases to the education of a drilling engineer. One being the technical part of his education; and the universities are equipped to administer that portion. However, upon graduation, he is only half of an engineer, and generally totally lacks the practical and the application phases of his education. Therefore, upon graduation we should be prepared to take over that part of the education of the engineer and supply him with the vast and detailed practical experience of our total operations. This experience and training should begin on the roughneck level and go through every phase and operation encountered in the field. It is only through such broad experience that the drilling engineer in training will acquire the detailed knowledge of our operations that will lead to the development of his judgment and so-called common horsesense, that are so necessary to his development and effectiveness in the ultimate supervision of our operations.

This field experience should follow the normal lines of advancement that now lead from the position of roughneck to driller to toolpusher and ultimately to the position of drilling superintendent. This sounds as though it was a long and tedious internship, and in fact it is. However, a drilling engineer in training should shorten these steps because such a man with an engineering background should not have to repeat a field operation but a few times to learn its signficance. In other words, it is presumed that a young graduate engineer will have better powers of observation and understanding than does the common boll weevil on his first job. One of the biggest lessons that a drilling engineer in training will learn outside of the mechanical operations of the field, will be the necessity of getting along with, cooperating with, working with and understanding the ordinary field hands, roughnecks, and common laborers that he will be in constant contact with throughout his whole career. Throughout his training program he must not only carry his end of the work, but he must establish the fact among the rest of the men on the crew that he is not only willing but able to do everything that they do, but he is able and willing to do a little bit more and do that a

little bit better. And he must not fall into the disastrous fallacy of assuming that his engineering education places him on a higher level in relation to field work than that of his co-workers.

When the drilling engineer in training has become familiar with and mastered every operation encountered on the roughneck level, when he has *earned* the respect of the other men on the crew, and gained their cooperation, he is then ready to be introduced to the operation of the rig. With a little such transitional training he is then ready for the job of driller. This will be his first supervisory job and if he is to be successful in this position, the rest of the crew must respect his judgment and abilities and he will only have that respect if he has earned it in the lower grades of work. When he takes over the job of driller he has proved to his employer that he is a good workman, has had sufficient experience to allow him to safely operate the rig without danger of injury to the crew, himself, or the equipment, and that he has had sufficient experience to know what to do in an emergency and above all to know that should he get into trouble, what action to take in order that the trouble will not be aggravated, and to know when the trouble is beyond his abilities and that he should contact his toolpusher. After he has obtained the position of driller, his experience mounts as he makes good on this job and his next job will be that of toolpusher or field engineer.

The Engineer's Function

When the drilling engineer in training has had enough experience in the position of driller to justify his further advancement, his basic field training period will have been completed, and he will be ready to advance to either the the position of field engineer or to the position of toolpusher. If he should at this point choose to go the toolpusher route, he will advance in that phase of the drilling operation having primarily to do with the actual drilling of the wells. This means the matters of directing the physical operations of drilling, seeing that the proper material is moved to the proper place at the proper time, and in general supervising and coordinating the utilization of equipment and men. On the other hand, if the drilling engineer in training chooses to go from the drilling job into the engineering field, his position as field engineer would entail the duties and responsibilities involving the technical aspects of the drilling operations. In high pressure blow-out areas it would be his responsibility to see that the rig was properly equipped and to see that the proper mud is used to assure the safest and most economical operation. It would be his responsibility to study the proper type of bit to be used in the formations encountered in order to obtain the greatest amount of footage in a given time at the lowest cost. It would be his responsibility to determine the proper amount of weight to be carried on the bit, and to specify the type and distribution of such weight. It would be his responsibility to keep an accurate check on the life of the drill pipe, analyze causes of failure. It would be his responsibility to supervise and insure the proper operation and maintenance of all mechanical equipment on the drilling rig. As field engineer he would be responsible for all of the engineering aspects of the drilling operations.

If the field engineer develops properly and demonstrates his ability to handle all of these duties and more, he would then be in line for promotion to the position of drilling superintendent. At this level his course of advancement would converge upon that of the engineer who had chosen the toolpusher route, as that man would also be in line for promotion to the position of drilling superintendent. In either event, the position of drilling superintendent would ultimately be filled by a man with an engineering training and common experience up to and through the level of the driller, but with slightly different experience between the position of driller and drilling superintendent. However, this divergence of experience should not be too great when it is considered that both the field engineer and the toolpusher both have an engineering background and the common experience to the level of driller and they will be working closely together in the respective positions of field engineer and toolpusher, and under such conditions will have ample opportunity to observe the other's operations.

A *New* Drilling Superintendent

Either of these routes should produce the ideal drilling superintendent, as he would be an engineer who had been thoroughly grounded and finished in practical training and who in addition would have the technical knowledge and abilities of a graduate engineer.

This position of drilling superintendent would be in many respects similar to the position of Chief Operations Engineer as found in many other industries. It would entail all of the duties and responsibilities now being carried by the drilling superintendent and having to do with the coordination and operation of the physical aspects of the drilling operations. This logistic control would go down from the drilling superintendent to the toolpushers and to the drillers. In addition to these now normal duties of the drilling superintendent, the position now under discussion would also include the duties of chief engineer and technical director and coordinator of all matters of an engineering nature. This engineering direction and control would go down from the drilling superintendent to the field engineers. In addition to the engineering executive control going downward, it would be the further duty and responsibility of this position to receive and to correlate information and data on field operations as gathered by the field engineers. Upon attaining the position of drilling superintendent, the drilling engineer would have his first executive position. In this position his authority would be absolute and his experience and training must have been so thorough that he will know intimately the details of the duties and operations of every man under him and he must be so seasoned and experienced that he will be able to form a complete picture of what is going on in the field when he has only meager and insufficient data for his conclusions.

The drilling superintendent will be called upon to use all of his engineering experience throughout the entire drilling of a well. When the well is submitted to him for bidding, he must analyze the area, the hazards involved, the amount of material to be used and the type of material, the time required to drill the well, and the nature of the completion. All of these things must be taken into consideration in making his bid, keeping always in mind that it is necessary for the drilling department, whether with an independent contractor

or a drilling company, to make a profit from their operations. He is solely responsible for the drilling of the well in the most economical manner possible. To accomplish this he must make use of all of his experience and resources to coordinate men and material and equipment toward the completion of the well in the shortest time. In all of his operations he will be continually fighting the clock and the calendar, because throughout the drilling operation labor amounts to one-third of the direct cost of the drilling of any well. Therefore, when the superintendent is able to shorten the time of drilling he will be reducing all direct cost in that same proportion and when these direct costs are reduced all other costs of operation decline accordingly. Although it should not be necessary to specifically point it out, nevertheless, the fact is frequently overlooked that the aim and purpose of a drilling contracting firm is not strictly of drilling wells, but is also that of showing a profit.

There is probably no phase of the oil industry where the need of good engineering exceeds that of the drilling industry. Also there is no branch of the oil business where the results of engineering, or the lack of results, will be shown more quickly than in the drilling industry. The reservoir engineer makes his prediction. It will probably be 10 or 20 years before anyone can prove him wrong. The geologist draws his map of our oil field with a pencil so that it can be easily changed as additional data is obtained. Whereas, in the drilling industry when a decision is made it is frequently only a matter of hours until the accuracy or error of such decisions are demonstrated.

The Industry Needs Engineers

The contract drilling business is a highly competitive business composed of many rugged individualists who have been able to stay in the business only by their intimate knowledge of the operations involved and their ability to work hard and long hours — all too often with little or no return for their labors other than to stay in business over the rough spots. These men have not been too ready to take on engineers lacking the peculiar requirements of this industry, because as wells are drilled deeper, the hazards are too great. By the same token these hazards are now approaching a level that makes it imperative that the industry employ graduate engineers with the proper undergraduate work, train them in industry, and advance them to positions where they will be able to study, control, and if possible eliminate some of the hazard of this critical business. And it is my firm belief that if the drilling contractors intend to stay in business and are compelled to go deeper and deeper, they must avail themselves of the services of engineers highly trained in this field.

The fact that there is a demand for engineers in this field is evident at the present time by the activities of several junior colleges in the mid-continent area and in California who have set up a two-year course in drilling engineering. This is an all too feeble attempt and falls far short of the need. These courses are little more than trade school courses and fail to give the student the broad fundamental training that is an absolute essential to the man going into this work. Various business analysts have estimated the mortality rate for drilling contracting firms to be 97%.[3] With these facts in mind it can be of little wonder that drilling contracors are reluctant to turn their engineering over to a man with anything less than the best in undergraduate engineering training and post-graduate field training, when a wrong decision can cost the contractor a few hundred thousand dollars or put him out of business. On the other hand, if the drilling industry had its proper complement of well qualified engineers we might be able to reduce this mortality rate appreciably.

It is true that the hazards of the drilling contracting business also represent equal hazards to the engineer employed in the business. But in spite of these apparent over-all hazards and insecurities it is believed that an engineer who has come up in this business from roughneck, driller, toolpusher or field engineer, as the case may be, would be a man that would be pretty hard to starve.

[3] E. C. Brown, Houston Meeting, A.A.O.D.C., October 11, 1948.

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Employment Notices

The *Journal* will post notices of men and jobs available. Companies and AIME members are invited to use this space, for which there is no charge. Write to the editor using the code number shown, or the address given in the notice.

PERSONNEL

♦ Graduate petroleum engineer, young, single, seven years' experience in various phases of drilling and production, desires position in Southwestern United States with major company or large independent. Minimum salary $6,000 annually. Code 102.

POSITIONS

♦ Petroleum Engineer — With at least ten years' varied field experience, knowledge of exploratory problems, administrative experience and the ability to plan large-sized operations. Permanent. Location, Turkey. Code Y2198.

♦ Petroleum and Natural Gas Engineers — For research work on primary and secondary recovery methods of petroleum production and on natural gas production in the U. S. Salaries, $3727-$5232 a year. Headquarters, Oklahoma. Code Y2218C.

♦ Sales Managers or Sales Engineers — 28-38, with an engineering background and sales experience in pumps or closely related fields. Knowledge of the manufacturing and handling of petroleum products helpful. Location, Michigan. Code Y2168.

For further information on the above positions available, write directly, using code number shown, to Engineering Societies Personnel Service, Inc., 8 West 40th St., New York 18.

♦ A principal New York City banking establishment is seeking a graduate in petroleum engineering or petroleum geology, preferably one with several years' experience in field engineering and with some practice in valuation of oil and gas reserves. This position offers experience in oil and gas research studies and property appraisals as well as the correlative advantage of experience in the field of financing and the financial aspects of the petroleum industry. Financial stability and probability of advancement are excellent. Code 506.

A.A.P.G. Honors G. C. Gester and F. M. Van Tuyl

Honorary Membership Awarded Each at Annual Meeting in Recognition of Distinguished Service in Petroleum Geology

GEORGE C. GESTER was born in Buffalo, New York, and studied mining engineering and geology at the University of Calif., receiving his B.S. degree in 1908. After teaching geology there for a year, he engaged in geological work for the Southern Pacific Railroad. He joined Standard Oil Co. of New York in 1914, working in mining engineering and geology, and was appointed chief geologist of the Standard Oil Co. of Calif. in 1917. He served in that position for the next 27 years, becoming consulting geologist for the company in 1944, where he still serves.

He has actively participated in the work of the American Association of Petroleum Geologists ever since his election to membership in 1920, giving freely of his time and talents in furthering geological science and the development of our nation's petroleum resources. His professional leadership was first given recognition in 1921 with his election to vice-president of the A.A.P.G., and was again recognized in 1927 by his promotion to the presidency of the Association. In addition to this service he has devoted much time to positions on various committees of the organization.

His published papers include *Observations Relating to Origin and Accumulation of Oil in California, World Petroleum Reserves and Petroleum Statistics*, and he was a joint author of papers on the Yates field in Texas and the Huntington Beach field in California.

FRANCIS M. VAN TUYL was born in Denmark, Iowa. After receiving an A.B. and then an M.S. in geology in 1912 from the University of Iowa, he continued graduate study in Columbia University and received the Ph.D. degree there in 1915. He then joined the faculty of the Univ. of Illinois, and in 1917 became assistant professor of geology at the Colorado School of Mines. He was promoted to the head of the Department of Geology in 1919, the position which he still holds today.

He has successfully combined his academic work with private consulting and has utilized every opportunity to engage in field work. He has spent many summers on a wide variety of practical problems in petroleum geology and exploration, which has brought to his classrooms a rich background of experience. As president of the Plains Exploration Co. from 1929 to 1941, he had an active interest in exploring for petroleum in the Great Plains area.

National professional recognition has been given him several times with appointments to committees and boards, particularly, in the field of research, and his active interest here has resulted in 100 or more articles being published by the geological journals. His *Elements of Petroleum Geology* is one of the best known of his published works. Also, he is senior author of *Annual Review of Petroleum Geology*, published by the Colorado School of Mines Quarterly.

Oklahoma Meeting Plans Nearing Completion

The program for the first joint meeting of the Oklahoma City and Mid-Continent Sections will be held on the campus of the University of Oklahoma, at Norman, on April 27. The meeting is coincident with the annual Engineer's Open House staged by the University students. The meeting has been planned primarily for the benefit of the University's record enrollment of petroleum engineering students, but has the secondary consideration of bringing Section members into touch with each other, and with the students.

The meeting is open to all who wish to attend. Large delegations from Oklahoma City and Tulsa are expected.

The semi-final program is as follows:

8:30 a.m.—Registration. Student Union Building

9:00 a.m.—Technical Session

Progress of Secondary Recovery in the Mid-Continent, by Albert E. Sweeney, Interstate Oil Compact Commission, Oklahoma City.

Interpretation of Penetration Logging Data, by Paul B. Nichols, Geolograph Co., Oklahoma City.

P. B. Nichols, head of the Geolograph Co., who will present *Interpretation of Penetration Logging Data* at the Norman Meeting. He has been active in geology since his graduation from the Univ. of Nebraska in 1927.

Usage of Carboxymethylcellulose Drilling Fluids, by John Pettigrove, Drilling Specialties Co., Bartlesville, Okla.

2:00 p.m.—Technical Session

Mercury and Gas Absorption Techniques Applied to Capillary Pressuree Methods, by John C. Calhoun, Jr., R. L. Schick and R. M. Caywood, Univ. of Oklahoma.

STUDENT PAPER CONTEST

Methods of Recovering Oil From the Athabaska Tar Sands, by James D. Murdock, Univ. of Oklahoma, vs. a paper to be presented by a Tulsa Univ. petroleum engineering student, title to be announced.

4:30 p.m.—Inspection of Engineer's Open House Exhibits

6:30 p.m.—Banquet, Student Union Bldg., Entertainment by O. U. Sororities. Principal Speaker, W. H. Carson, Dean of Engineering, O. U., "Engineering Observations Around the World."

Film Reviews

Program chairmen for local section meetings may find a wealth of material in films concerned with the oil industry. There is a wide variety of films available which may be used for this purpose. A short review of some of these is given below. Write directly to the address given in the review.

DEEP HORIZONS — 16mm sound, 32 minutes, color, revised 1948

Portrays the determination of location by seismograph, drilling the well, and bringing it in. Water operations off the Louisiana coast are also shown. *The Texas Company, 135 East 42nd Street, New York 17, N. Y. Free on loan. From Association Films, Inc., New York, N. Y., Chicago, Ill., San Francisco, Calif., and Dallas, Texas, or from any of the following offices of The Texas Company: Atlanta, Boston, Buffalo, Butte, Chicago, Dallas, Denver, Houston, Indianapolis, Los Angeles, Minneapolis, New Orleans, New York, Norfolk, Seattle.*

OIL FROM THE EARTH — black and white, 16mm sound, 18 minutes, 1941

Traces oil from the bowels of the earth to refinery. First demonstrates scientific methods of locating oil strata far beneath the surface of the ground. After location is determined, a derrick is built and drilling operations commence. Thousands of feet down, core samples show evidence of oil, so steps are taken to place the well into economic operations. Valves are readied to control the flow, while pipe lines are laid to carry the oil from the well to the refinery. Modern well is shown in interesting contrast to an oriental seepage well of ancient times. *Shell Oil Company, Inc., 50 West 50the Street, New York 20, N. Y. Shell Oil Company, Inc., 100 Bush Street, San Francisco 6, Calif. Free on loan from both New York and Pacific Coast Offices.*

PETROLEUM GEOLOGY — 16mm sound, black and white, 30 minutes, no record, year produced

Astronomy, geology and palaeontology furnish science introduction to the work of the oil geologist who tells the driller where to sink his hole and how deep to go. The changing topography of North America is traced and coordinated. *United World Films, Inc., 445 Park Avenue, New York 22, N. Y. Rental $4.50.*

PROSPECTING FOR PETROLEUM — 16mm sound, 35mm sound, color, 23 minutes, 1947

First in a series of six films which will cover all phases of the oil business. It explains the geology of oil formation, shows how oil was first discovered in America, traces the development of modern scientific methods of oil exploration. Threedimensionalanimationis used throughdimensional animation is used throughout to simplify and dramatize the technical aspects of the subject. Produced by George Pal, using his "puppetoon" techniques. *Shell Oil Company, Inc., 50 West 50th Street, New York 20, N. Y. Shell Oil Company, Inc., 100 Bush Street, San Francisco 6, Calif. Free on loan from both New York and Pacific Coast Offices.*

BURTCHAELL OR BETHANCOURT?

It was recently pointed out to us—discreetly, of course—that we had identified E. P. Burtchaell of San Francisco as R. J. Bethancourt of Corpus Christi in the March *Journal*. We are sorry, and hereby correct the mistake by telling you that the gentleman on the left is Burtchaell. But who would guess it?

Book Reviews

HOW TO KEEP INVENTION RECORDS

By Harry Aubrey Toulmin, Jr., Research Press, Inc., 137 N. Perry St., Dayton 2, Ohio.

This book shows you how to prove your rights; the record system described will lay the foundation for the protection of your ideas in patent law suits. Authoritative—concise—completely revised up-to-date — based on the latest Supreme Court Decisions.

PATENT LAW

By Harry Aubrey Toulmin, Jr., Research Press, Inc.

Patent Law for the Executive and Engineer has been completely revised and brought up to date with the latest changes in the law based upon decisions of the United States Supreme Court. It is ap ractical volume and a handy manual to give quick answers. The author, a corporation lawyer, who is counsel for many of the leading corporations of the United States, has written this book out of his practical experience. The book shows you how to develop and protect your inventions so that you can succeed to make them profitable, and teaches you what to do and what not to do so you can earn the money from your inventions.

OIL AND PETROLEUM YEAR BOOK 1948

Compiled by Walter E. Skinner, 20, Copthall Avenue, London, E.C.2. pp. 236. Post free (Inland) 15s. 9d. net; Post free (Abroad) 16s. net.

This issue, which represents the 39th edition of the Oil & Petroleum Year Book, is a record of oil companies operating in all parts of the world. It supplies complete particulars—officers, nature of business, capital, accounts, objects, properties, subsidiaries, production — of 660 companies engaged in all branches of the industry. Detailed information on producers, refiners, transporters, dealers, and oil financiers is given in this volume, as well as a list of managers, engineers, agents, and other oil industry personnel, with their addresses and the names of the companies with which they are connected.

The specific information with respect to each company listed gives oil-interested people an over-all picture of the industry as it operated in 1948. ★ ★ ★

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Permian Basin Section Activities

By Tom W. Flewharty

The Permian Basin Section's third meeting of the year was held in Midland's Scharbauer Hotel on March 2. Program Chairman W. N. Little introduced H. W. Brennan, with Core Laboratories in Midland, who presented a paper entitled *Core Analysis Applicable to Fractured and Vugular Dolomites.* J. E. Bliss, Rotary Engineering Co., Midland, led a discussion of the paper after Brennan concluded. A summary of the paper follows:

It was explained in a short history of coring that the old rule of thumb "good core recovery, poor well" was becoming less applicable with each advancement in coring method and analysis.

Information first obtained from cores proved of little value. Visual inspection indicated that the effective porosity and permeability was contained in fracture and vugular systems which were sometimes augmented by large solution cavities, and not in the primary crystalline structure of the formation.

Experience has shown that it was almost useless to analyze small core fragments from these systems and that it is now apparent that core segments must be about one-and-one-half feet in length to present the most accurate results. This innovation is so recent that proper correlation between laboratory results and well production has not been obtained.

H. W. Brennan presented *Core Analysis Applicable to Fractured and Vugular Dolomites* at the March 2 meeting.

A discussion of the analysis of a core followed, starting with the extracting of the core from the well and ending with the tabulated data obtained from the analysis. A modification of the Dean-Stark method is used in obtaining oil, gas and water bulk from the sample, each of which is extracted from the core by means of a vacuum and an extracting fluid.

Data obtained from this completed operation is the volume of residual gas bulk, total volume of water extracted—formation water being obtained by the difference—and oil bulk being weight loss over and above the total volume or weight of water out.

If the gravity of the produced oil is known, the volume of the extracted oil can be calculated. Porosity then will be the summation of oil, water and gas bulks when expressed in percentage of rock volume.

Permeability is measured in two horizontal directions, maximum and 90 degrees from maximum. The maximum is obtained by pushing air through the sample and revolving it until the maximum air flow through the sample is obtained. The core is then turned 90 degrees and the air flow is measured again.

Though some field operators question the value of permeabilities measured in this way, Brennan believes that the permeability of an entire section thus measured is representative of the capacity of the section to produce, but that individual permeabilities are of small value. Permeability measured in this way takes into account both the permeability of the matrix and the fracture and/or vugular system.

The final step in the analysis is the measuring of porosities. There are three porosities that must be determined—total, matrix, or primary, and fracture, vugular or both. The water saturation method is used to obtain the bulk volume and the primary porosity. Secondary porosity then may be calculated.

In summing up the value of this type of core analysis, some sources of error were pointed out. The invasion of drilling fluid into the core, resulting from the indirect method of obtaining the oil bulk of the core, error caused by breakage of the core when removing from the barrel, and human error can be eliminated, in a large degree, by constant experimentation and supervision.

Brennan concluded that reliable data can be obtained from this sort of analysis, but that at the present time it is in the experimental stage and must be correlated with reservoir performance to be of real value.

Bliss then demonstrated some differences in methods of analysis which are used in his laboratory.

Personals

R. B. L. McCULLAR has joined the sales staff of The Western Co. in Midland. He will specialize in selling the company's acidizing service and jet formation shooting. From 1936 until 1948 he was manager of the Mid-Continent division of Lane-Wells Co. in Oklahoma City.

RAY S. OUSTERHOUT, former service engineer with Dowell Incorporated in El Reno, Oklahoma, has been named sales engineer for that company in Odessa, Texas. Ousterhout is a graduate of the University of Tulsa, and a veteran of World War II. He started with the firm in 1943. ★ ★ ★

MUSKAT TO LECTURE AT KANSAS UNIVERSITY

Morris Muskat, chief of physics division of Gulf Research and Development Co., will present his series of lectures on reservoir engineering at Kansas University on May 5, 6, and 7. The lectures are being sponsored jointly by the petroleum engineering department of the university, under the chairmanship of Charles F. Weinaug, and the Kansas Section of AIME. The Kansas Section will hold a dinner during the course of the lectures. The Hotel Eldridge in Lawrence, Kansas, is recommended for accommodations.

Kansas Section Activities

By Carl Lund

The monthly meeting for the Kansas Section was held March 2 in the Bamboo Room of the Broadview Hotel in Wichita. In a short business session following the dinner, Paul Witherspoon and Fred Kluck announced that they will present details and plans at the next meeting for a field trip through the Greenwood County water flood properties. C. F. Weinaug announced the Muskat lectures at Kansas Univ. (see page 20, Sec. 1).

George B. Collins, a Wichita attorney, entertained and informed the group with a discussion on "Legal Aspects of Petroleum Production and Unitization in Kansas". A summary of his presentation follows:

The actions of the petroleum engineer are constantly being influenced by someone's legal right, and if the engineer understands the rights of the landowner he can settle about ninety per cent of the legal problems that will arise in his profession.

The landowner owns the surface of his land and all minerals to the center of the earth. He is free to decide whether or not he will lease or develop his property. In the case of development, about the only restrictions he will encounter are with reference to his neighbors' boundary lines and proration. The owner is protected by law against subterranean trespass, as well as trespass on the surface. The landowner has the right to protection against drainage by wells on adjoining lands and the right to have sufficient protection wells drilled and likewise the right to have such a number of wells drilled as will reasonably exhaust the ability of the premises to produce oil. If the lessee is derelict in his duties, the law allows the landowner damages in a proper action.

When the landowner leases his property, he acquires some new rights, and the lessee assumes certain duties, many of which do not appear as express provisions in the lease, but are enforced as implied covenants. The implied covenant which involves the petroleum engineering profession most is that which requires diligent and efficient operation of the premises. In developing the premises the lessee must observe the drilling of the upper formations and test them, if necessary, by the best methods known and accepted by the industry. When the hole is drilled to the producing formation, the lessee owes the duty to complete the well in such a manner as to permit its maximum production. In no event in the lessee permitted to prematurely abandon a well.

The rights of a mineral owner are very similar to those of a landowner. In Kansas he has the co-equal but not exclusive right to lease the premises or drill thereon, and he may maintain an action for breach of implied covenants without the joinder of his co-owner.

George B. Collins of Wichita, speaker for the March meeting.

The landowner has the right to grant or deny a permit for geophysical exploration or other types of geophysical survey. In the event such rights are invaded, the law provides a remedy in damages for the disparagement of the mineral value of the land.

A unitized lease simply places the the ownership of the various parties in the same category as if it were united in one person. Although this presents a greater problem in that it is more difficult to get all of the owners to agree, the lessee should unitize for conservation purposes where it is possible.

Personals

M. F. WESTFALL, petroleum engineer for the Cities Service Oil Co. in Madison, Kansas, is being transferred to Graham, Texas to serve as district engineer. ★ ★ ★

Two groups at the March 2 Meeting in Wichita

Left: left to right, rear — Dave Wilkie, Wayne Capron, H. D. Raymond, Stan Jervis, E. B. Harry; front — J. C. Henderson, J. B. Ladd and Max Kliewer.

Right: left to right — K. W. Harris, W. C. Moody, E. S. Arnold, R. J. Curlan, P. A. Witherspoon, R. C. Robson and J. A. Cummin.

Delta Section Activities

By J. Paul Ratliff, Jr.

A color movie called "Yellow Magic", with local sulphur mining scenes of Grande Ecaille, was presented by Z. W. Bartlett of the Freeport Sulphur Co. at the March 8 meeting in the New Orleans Petroleum Club.

Bartlett, who is assistant superintendent at Grande Ecaille, made a short talk prior to the showing of the film. During this talk he presented some pertinent facts and figures on the present sulphur market. He stated that prior to the war sulphur was being produced throughout the entire world. In 1937-38 only 28 per cent of the world's production was coming from the Gulf Coast area with the remainder being supplied by Spain, Italy, Sicily, and Japan. However, in 1949 Louisiana and Texas alone supplied 49 per cent of the world's sulphur.

At the conclusion of the motion picture, the meeting was opened for discussion. Bartlett stated that at the present time his company was averaging one sulphur well per acre at the Grande Ecaille field. He added that the producing life of the well was only three months, with well failure resulting from three causes: (1) shearing of the casing due to the settling of the earth around the hole, (2) actual depletion of the sulphur underground, and (3) corrosion of the casing.

Chairman E. N. Dunlap presided at the meeting which was attended by 70 members and guests. He stated that the Petroleum Branch has been invited to hold its 1950 Fall Meeting in New Orleans, and that an investigation is now being made of available accommodations. An answer to the invitation will be given shortly.

Plans for Section Activities

Plans for Delta Section's activities during the remainder of the year and for 1950 are taking form. The following is a tentative outline of the program:

Financing of Oil Producing Properties is to be discussed by C. Leslie Rice, assistant vice president of the Empire Trust Company of New York. Included on this program will be an introductory talk by a local member on the problems involved in the evaluation of oil properties in connection with financing.

Russell B. Brown, Counselor for the Independent Petroleum Association of America, Washington, D. C., will give an informal talk on the current happenings at the Capitol.

K. H. Crandall, vice chairman of the board of The California Co. and E. G. Robinson, area manager of Shell Oil Co., both of New Orleans, are to participate in a discussion on management and organization.

Other talks on improved drilling methods, on special purpose drilling fluids, on problems encountered in lifting oil from great depths, and on operating problems incident to production from unitized condensate-black oil reservoirs are either being arranged or being considered. It is anticipated that all of these will be prepared locally.

The program committee has tentative plans for a field trip during the summer. The activities committee, in addition to arranging for the student paper competition, is laying the groundwork for a dance early in the fall. ★ ★ ★

Gulf Coast Section Activities

By J. E. Kastrop

Regional and national conventions of other oil industry professional associations coincident with the regular March meeting of the Gulf Coast Section brought the attendance somewhat below average, but the meeting went off as scheduled with those present making up in enthusiasm for what attendance lacked in number.

Owen Thornton presided, giving a brief account of the San Francisco meeting. He gave a short report on the financial status of the Institute as presented at the West Coast gathering. Expressing the sentiment of the Section, Thornton stated that he hoped a more detailed financial statement would be available to the members so the controversial issue of increased dues might be more logically discussed. He announced that the Fall Meeting will be held in San Antonio at the Plaza Hotel under the auspices of the Southwest Texas Section of Corpus Christi. The Petroleum Recovery Conference was also announced. It was held at A. & M. College of Texas on April 6-8, 1949, and included 16 outstanding papers by prominent engineers on the subject of increasing oil recovery in Texas. A. B. Stevens of A. & M. is chairman of the conference.

More than normal amount of interest was expressed in the main topic of discussion of the March meeting held at the Houston YMCA. Featured subject of the meeting was a paper entitled *A Study of Oil and Gas Conservation in the Pickton Field,* by J. R. Welsh, R. E. Simpson, J. W. Smith and C. S. Yust, all petroleum engineers, Humble Oil & Ref. Co., Houston. Welsh presented the paper, which gives the results of a complete reservoir study designed to determine a sound economic program for the conservation of oil and gas in the Pickton field, Hopkins County, Texas. The paper was carried in full in the March issue of the *Journal.*

Personals

G. F. Abendroth, former district petroleum engineer at New Iberia for Humble Oil & Ref. Co. was recently transferred to the company's Houston office. He will serve in the production practices section of the petroleum engineering division.

Harvin Landua, 1948 secretary-treasurer, Permian Basin Section, and district petroleum engineer for Humble Oil & Ref. Co. at Odessa, was also transferred to the company's Houston office in the production practices section.

F. L. Thompson, a member of the East Texas Section, visited the Gulf Coast Section at the March meeting. He is with the Humble Oil & Ref. Co. ★

Mid-Continent Section Activities

By Jack H. Beesley

H. H. Kaveler, assistant to vice president in charge of production for Phillips Petroleum Co., was the principal speaker at the monthly meeting on March 14, 1949. This meeting was held at the McKinley School in Bartlesville, giving the group from that city a home meeting. A very large delegation attended from Tulsa. The subject of Kaveler's talk was *Case Histories of Increasing Well Densities.* He introduced many slides graphically showing the production of different fields and the relationship to well spacing.

Kaveler suggested that the AIME sponsor a program to study better well spacing and that such information be kept in front of those in management positions. Kaveler, a graduate of both the Missouri School of Mining & Metallurgy and the University of Maryland, has been with Phillips Petroleum Co. since 1936.

Election of Officers

Following is a list of the newly elected officers for the Mid-Continent Section who will serve for the 1949-50 term:

H. M. Cooley, Bethlehem Steel Co., chairman

Roy H. Smith, Stanolind Oil & Gas Co., 1st vice-chairman

J. N. McGirl, Tide Water Associated Oil Co., 2nd vice-chairman

J. H. Beesley, Baroid Sales Division, secretary-treasurer

Executive Committee — Tulsa:

W. L. Horner, Barnsdall Oil Co.

W. H. Burke, Shell Oil Co.

G. M. Stearns, Stanolind Oil & Gas Co.

Executive Committee — Outside of Tulsa:

J. A. Murphy, Continental Oil Co., Ponca City

A. B. Cook, U. S. Bureau of Mines, Bartlesville

H. H. Kaveler spoke on *Case Histories of Increasing Well Densities* at the March 14 meeting.

Personals

HERBERT A. KOCH, *Journal* secretary and sales engineer for Dowell, Incorporated, is being transferred to Fort Worth, Texas, where he will be division sales manager. Koch has been very active in the AIME and other organizations in Tulsa.

HAROLD SIDWELL, engineer for the Union Tank Co., has resigned his position here to take an assignment with the Hiawatha Oil & Gas Co. He will headquarter in San Antonio, Texas.

HENRY KEPLINGER of Keplinger and Wanenmacher, Petroleum Engineers, left March 20 for London. After a brief visit there he will then go to make a survey of the Middle East oil fields. This trip is in conjunction with a joint project with Frederick R. Harris, Inc., Consulting Engineers of New York and San Francisco. He will be gone about three weeks. Keplinger visited Mexico City and the Posa Rica oil fields recently.

Study Groups

The Production and Drilling Study Group Meeting was held March 29. H. M. Cooley of the Bethlehem Steel Co. discussed "Casing Design." ★ ★ ★

A group of Mid-Continent Section members taken at the March 14 meeting in Bartlesville. Left to right (standing): W. L. Horner, H. M. Cooley, Kenneth Eilerts, John Hammond, Jack Tarner, Glen Stearns, Roy Smith, Jack Beesley, Russell H. Gwinner, Alton B. Cook, W. P. Parker. Left to right, (seated): J. M. Wanenmacher, Myer Dubrow, P. E. Fitzgerald, C. O. Moss, Charles Rodd, Harold Crisman, A. W. Walker, George Elliott.

Oklahoma City Section Activities

By Harold Sells

February Meeting

John N. Terry of Lane-Wells Co. presented an excellent lecture on radioactivity well logging at the Section meeting held in the Biltmore Hotel, Oklahoma City, on February 23. The lecture employed the latest technique in visual instruction, using cartoon characters "Super-Gam", "Little Neutron", and "Super-Super-Gam" in a presentation of the complete radioactivity story.

Although his paper was entitled *Introduction to Radioactivity Well Logging*, Terry discussed details of the theory, application and interpretation of radioactivity logging, advancing considerably beyond the introductory phase. A gamma ray log identifies formations or stratigraphy, which is impossible on a neutron curve, and may be interpreted without additional information. It is impossible to supplement the neutron curve with other geological data without a gamma ray curve since shales and porosity in sandstones and limestones develop essentially the same "kick" and one could easily be mistaken for the other.

C. E. Reistle, production manager of Humble Oil & Ref. Co. of Houston, who spoke to the Petroleum Engineering Club at the Univ. of Okla. on March 11. His subject was "Important Practical Aspects of Development and Operation."

Type formations, such as highly radio active shales or low value limestones and sandstones afford excellent markers for gamma ray correlation. Neutron correlation may be made on indicated porous zones in either sandstone or limestone. It must be remembered that on a gamma ray log shales are recorded as high values compared to lower values on the neutron curve. This is a result of the high percentage of connate water in all shales. Radioactive formations have a great effect on the gamma ray curve, but the influence of these same formations on a neutron curve is negligible.

Fluid or gas within the formation is not indicated on a gamma ray curve; however, it is reflected on a neutron curve as a possible porous zone. The gamma ray log, also, does not indicate fluid level within the bore hole as does the neutron curve. It is the function of the neutron log to identify porous zones in sandstones and limestones by means of the relative amount of hydrogen contained in these formations.

An interesting discussion followed the lecture and included the comment that correlation of radioactive logs with core analyses in one field indicated that one foot shale and sand zones could be detected from the radioactivity logs.

March Meeting

On March 16 Francis Anderson of the Halliburton Oil Well Cementing Co. presented a subject entitled *Use of Resin Cement in Sealing Off Permeable Formations*. A forty-five minute discussion followed with all of forty present taking part.

Highlight of the talk was a slide illustrating the penetration and bonding effect of resin cement as compared to normal cement by itself. Resin cement was indicated to have no thermal shrinkage on setting and with it penetrating from one to three inches into the formation, an excellent bond results. Penetration of the resin cement was indicated to be rather uniform, regardless of permeability of the formation.

Current applications include:

1. Squeeze cementing for water and gas shut-off.
2. Plug back work to shut off bottom water.
3. Cement lower portion of production string or to cement liner when good cement job is critical factor in well completion or repair.

April Meeting

Plans are being made for a one day area AIME meeting to be held at Oklahoma University, Norman, Oklahoma, on Wednesday, April 27. The meeting will feature morning and afternoon sessions, closing with a banquet that evening. In addition to technical papers presented by members of the Mid-Continent and Oklahoma City Local Sections, student papers will be presented by Oklahoma City and Tulsa University students. The meeting will be held during the annual "Round-Up" so that school exhibits connected with this event will be on display at this time.

Local Members Present Papers at A. P. I. Meeting

Several members of the Oklahoma City Section presented papers at the A.P.I. Mid-Continent District Meeting on March 23-25. Joe H. Field, Sohio Petroleum Co., Oklahoma City, was chairman of the program committee for this meeting, which included the following papers by local members:

Ward M. Edinger of Production Engineering Laboratories presented *Interpretation of Core Analysis—Results on Cores Taken with Oil, or Oil-Base Mud.*

John C. Calhoun, University of Oklahoma, and F. E. Suder, of the Ohio Oil Co., Eureka, Kansas, gave a paper entitled *Water Flooding Calculations.*

Lincoln Elkins, of Sohio Petroleum Co. and present chairman of the Oklahoma City Local Section, and M. H. Dubrow, of Continental Oil Co., Ponca City, presented *Pressure Gradients in Flowing Oil Wells.*

R. C. Curtis and T. W. Brinkley, both of Carter Oil Co., Oklahoma City, presented *Calculations of Natural Condensate Recovery.*

Continued on next page

East Texas Section Activities

By Roy F. Beery

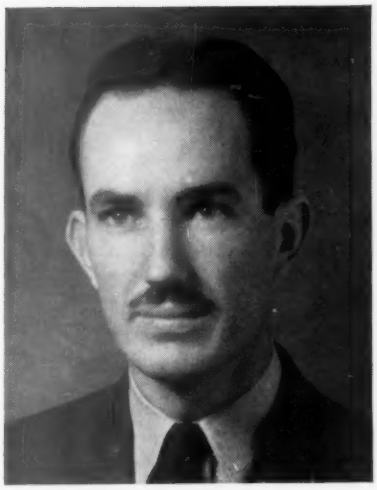
The East Texas Section held its March meeting at the Kilgore Hotel, Kilgore, Texas. Following dinner, D. W. Akins, Jr., The Ohio Oil Co., Shreveport, reported on the Annual Meeting held in San Francisco. Akins led a discussion of the Institute's plans to submit to the membership a referendum on a temporary increase in dues for the years 1950, 1951, and 1952. The discussion brought forth considerable differences of opinion on the matter. A committee of six was appointed to study the proposed referendum and report back to the Section with a recommendation for individual member action.

Chairman Jack Shepherd announced the program of the Petroleum Recovery Conference sponsored by the Texas Petroleum Research Committee to be held at A. & M. College of Texas on April 6-8, and asked P. J. Lehnhard, field chairman of the East Texas Engineering Association, to check on the desirability and availability of the papers for presentation at a future East Texas Section Meeting.

The feature of the meeting was a review of "Development in East Texas in 1949" by G. C. Clark, district geologist with Stanolind Oil and Gas Co., Tyler, Texas. Clark reported that 21 wildcat wells were completed as oil or gas wells, representing 14 per cent of the total number of wildcat wells. This discovery rate was almost double the discovery rate for 1947. At this time, however, Clark thought that none of the completions would be major discoveries with the exception of the Mitchell Creek field, a Paluxy sand discovery by Shell Oil Co. on an extension of the Talco fault system.

The East Texas District, as reviewed by Clark, consists of Railroad Commission Districts No. 5 and No. 6, including 42 counties in the northeastern corner of the state. The district contains three geological provinces, the Mexia-Talco fault zone, the East Texas or Tyler embayment and the Sabine uplift, with the prime objectives being the Subclarksville Woodbine, Rodessa and Pettit formations.

Clark described the 21 new discoveries, revealing the basis for drilling, whether on sub-surface data, seismic data, or surface geology, and gave an up-to-date report on the subsequent operations in the field. He fascinated the group by reciting perforated intervals, initial potentials and total depths for all 21 new completions without the use of his notes.



G. C. Clark of Tyler, who spoke to the East Texas Section March 23 on "Development in East Texas in 1949."

Although not completed at the end of the year, the Humble No. 1 McWatters, southern Freestone County, was the most important deep exploratory well drilled in the district. The well was drilled to 16,374 feet and provided additional control on the Smackover. Clark stated that the dip and thickening of the Cotton Valley zone between the Mexia pool and the No. 1 McWatters indicated that the Smackover would probably not be reached above 20,000 feet in the center of the East Texas basin.

Shepherd announced that the next meeting of the section would be held April 12 at Shreveport, La., and the Shreveport Geological Society will be invited to attend. Present plans are to invite Percy Erwin, engineer with Frank Speller, consultant at Tyler, Texas, to present a recent reservoir study of the Lisbon Field.

Personals

Congratulations were offered F. L. THOMPSON, JR., at the March meeting when it was announced that he is being transferred to the Kelsey Bass district office of Humble Oil and Ref. Co. as district engineer. Thompson has formerly been a petroleum engineer in the London district. MITCHELL STARK was appointed to the program committee to replace Thompson. ★ ★ ★

Oklahoma City Personals

Sohio Petroleum Co. of Oklahoma City has announced the following promotions and changes in Production Operating personnel:

BURTON WHITELEY has been advanced from assistant chief engineer and head reservoir engineer to chief engineer.

R. L. MCCORMICK has been advanced from evaluation engineer to head evaluation engineer.

JOHN T. COOKE has been advanced from petroleum engineer to head reservoir engineer.

LINCOLN ELKINS will continue in the same capacity as head special projects engineer, but will supervise the production research laboratory.

GEORGE B. KITCHELL of Houston has been added to the drilling department staff of Kerr-McGee Oil Industries, Inc. As assistant to TRAVIS M. KERR, vice president in charge of drilling, he will be in charge of field operations with headquarters in Oklahoma City. Kitchell formerly served as engineer in charge of drilling equipment for Humble Oil & Ref. Co.

RICHARD T. CHAPMAN has been named senior geologist in Stanolind Oil & Gas Co.'s central division office in Oklahoma City. Chapman comes from Shreveport where he was district geologist.

GRADY E. JOHNSON has joined the staff of Subsurface Engineering Co., Oklahoma City, as petroleum engineer. He formerly lived in Beaumont, Texas. ★ ★ ★

North Texas Section Activities

By Kenneth F. Anderson

An exceptional crowd of about 160 members and guests of the North Texas Section met at the Holt Hotel in Wichita Falls on March 25 to hear a talk by William L. Horner, chief engineer of Barnsdall Oil Co., concerning pressure maintenance. At the invitation of Chairman Don Harlan, William H. Strang gave a brief discussion of the functions of the AIME and the requirements necessary for membership. Following Strang, Vice Chairman I. E. Curtis introduced the speaker, who is well known throughout the industry for his contributions to reservoir engineering.

William L. Horner, Barnsdall Oil Co., spoke on pressure maintenance as a means of secondary recovery at the March 25 meeting in Wichita Falls.

Horner discussed and presented curves illustrating the past histories of the West Tepetate field, La., Midway field, Ark., Longville field, La., and Newhall-Potrero field, Calif. Pressure maintenance is being practiced in each of these fields in the following manner: Midway and Longville fields by water injection; a combination of water and gas injection in the Tepetate field; and gas injection in the Newhall-Potrero field.

LEFT—Tom E. Morton, Halliburton Oil Well Co., Wichita Falls, a director of the North Texas Section for 1949.

RIGHT—Patrick H. Riordan, Gulf Oil Corp., Fort Worth, replaced S. V. McCollum as 1949 sec.-treas. of the North Texas Section.

Of these fields pressure maintenance was started first in the Midway field in Arkansas during the early part of 1943. At the time water injection began in the Midway field the reservoir pressure had declined about 250 psi, which was about 130 psi above the saturation pressure of the reservoir oil. Since that time there has been a gradual increase in both the reservoir pressure and production rate and the estimate of ultimate recovery has been increased by more than 100 per cent.

Water injection was started in the Longville field in November 1948 and a favorable response was noted almost immediately. Although this project is in the early stages, all indications at this time suggest that the benefits received will far exceed the expenditure made for pressure maintenance. Here too the ultimate recovery estimate has been doubled, and the allowable has been increased about 1000 bbl. per day in spite of the present trend of regulatory bodies to cut production.

The Miller No. 1 reservoir of the West Tepetate field is one of the few examples of pool performance with simultaneous injection of gas into the gas cap and water into the flanks. This reservoir had a gas cap and the injection of water for primary pressure maintenance in the oil reservoir presented complications in the prediction of injection requirements and in the control of total water influx so as to minimize possible losses of oil into the gas cap. It was then determined that operation of the dual-injection system was necessary to prevent waste in this pool and now as a result of its use the estimated ultimate recovery of oil has been increased several million barrels. The Miller No. 3 reservoir of this field did not have a gas cap and there water injection alone was applied effectively.

Horner used the Newhall-Potrero field as an example of the application of material-balance calculations to a field being considered for primary pressure maintenance by the injection of gas. In making the predictions the ratio of relative permeability of gas to oil was determined from field data; however, the relative permeability to oil was determined from laboratory data. These were utilized to calculate productivity-index decline and to convert the material-balance results to a basis of pressure and production versus time, which is required for calculating economics. Curves illustrating calculated recovery and the actual recovery were shown and they check very closely. ★ ★ ★

Southwest Texas Section Activities

By Raymond Keller, Jr.

Due to a conflict in dates with the spring meeting of the A.P.I. the attendance at the regular monthly meeting of the Southwest Texas Section was decidedly below the last meeting. Refreshments and supper were served to seventy-four members and ninety-two guests in the Terrace Room of the Driscoll Hotel at 6:30 on March 9. Speaker for the meeting was George C. Howard of Stanolind Oil and Gas Co.'s Research Department, Tulsa, Oklahoma.

His paper, *Factors To Be Considered in Obtaining Proper Cementing of Casing*, was prepared by Howard and J. B. Clark and touched off one of the most lively discussions in the history of the section. Howard frankly stated that the opinions expressed in the paper were those of a research engineer and while he was convinced of the correctness of them today, tomorrow's further tests might prove them wrong and hence change his views. Howard's paper was reviewed in the Kansas Section Activities report in the March *Journal*.

Personals

BARRETT BOOTHE, district engineer for Houston Oil Co. at Beeville, has been promoted to chief engineer and moved to Houston. He will be replaced in Beeville by O. G. MCDOWELL. ★ ★ ★

Some of those attending the March 10 meeting. Left to right: Norris Johnston, Norman B. Clark, Ernest K. Parks, Dean Sheldon, Paul Andrews and Charles McClure.

Basil P. Kantzer, manager of California field operations for Union Oil Co.; member of the Council of Pacific Petroleum Chapter for 1949, and chairman of luncheon meetings. He is a native of Utah and a graduate of Stanford Univ.

Junior Group Activities Pacific Petroleum Chapter

By Norman B. Clark Jr.

The Junior Group held its monthly meeting on March 10 at the Rio Hondo Country Club, Downey, California. Dean H. Sheldon, consulting petroleum engineer, delivered a most interesting talk on "Views on the Evaluation of Oil Field Properties" before a record crowd. Sheldon, a Texan by birth, is a graduate of Stanford University and has been working in oil fields since graduation. He is very active in the Pacific Petroleum Chapter of the AIME as well as being a member of the A.P.I. and A.A.P.G.

Sheldon brought out many interesting ideas on evaluations. He discussed the different meanings of value, mentioning and discussing such terms as real value, exchange value, replacement value, forced sale value, enterprise value, etc. He presented the view of different parties when buying, when selling and when making loans, and emphasized that certain stipulations in lease agreements could increase or decrease the value of a property.

April Meeting

At the April 14 meeting the Junior Group of the AIME plans to sponsor an "Oil Well Completion Panel". The members of the panel will be: John Fraser, Union Oil Co., John Hills, General Petroleum Corp., C. Davis, Richfield Oil Co., M. Loy, Schlumberger Corp., W. W. Robinson, Texas Co., and J. A. Klotz, California Research Corp. The panel will discuss problems pertaining to drilling fluids, electric logging techniques and interpretations, casing programs, cementing procedures, washing fluids and methods used in well repair work. R. L. Parsons of the California Research Corp. will act as moderator.

Personals

THAD RANDOLPH, formerly Mid-Continent Division manager of Oil Base, Inc., has been appointed sales manager of the company. He will be stationed at the home office at Compton, Calif. ★ ★

Dean Sheldon, consulting petroleum engineer in Los Angeles, addressing the Junior Group at Rio Hondo March 10 on the subject "Views on the Evaluation of Oil Field Properties".

Student Chapters Are Active in Petroleum Engineering

Fifteen Student Chapters and Affiliated Student Societies of the AIME, located at universities and colleges from coast to coast, are now engaged in petroleum engineering activities. They operate with the cooperation of the petroleum engineering departments of their schools and the adjacent Local Sections of the Institute.

The aims and objectives of Student Chapters are very similar to those of any Local Section, and they function in much the same manner. Meetings are ordinarily held monthly, with programs selected on the basis of professional interest. Although they are affiliated with the Institute, they are fundamentally college societies and are self-governed.

Robert Watchous, president of the recently organized Student Chapter of AIME at the University of Wichita. A native of Matfield Green, Kansas, he has practical oil field experience, and served 33 months in the U. S. Navy.

Members can be classified as Student Associates, which may be the first step in a long affiliation with the Institute.

The officers of the chapters consist of a president, vice president, a secretary, and a treasurer. In addition to these, the chapter selects an AIME member as a Faculty Sponsor, and a Counselor. The Counselor must be a member of the Institute in the practicing profession, and he is normally appointed through the nearest local section. He serves to broaden the contacts of the chapter and assists with arrangement of programs.

OKLAHOMA OFFICERS

The present officers of the Petroleum Engineer's Club, at the University of Oklahoma, are:

President, Donald O. Powell

Vice-President, Theodore G. Ward

Secretary-Treasurer, Clifford L. Banks

St. Pat's Representative, Kenneth R. Boles

Chairman of Open House Committee, Spencer Taylor

Chairman of Entertainment, Preston Rennie

At the present time the club has 384 paid up members.

The University of Southern California Chapter of AIME commenced their spring activities with a March 11 dinner meeting. Richard L. Parsons, chief research engineer of the California Research Corp., spoke on the possibilities and problems of secondary recovery as applied to oil field practice.

Recovery Conference Held at Texas A. & M.

A successful Petroleum Recovery conference was held at Texas A. & M. College April 6-8, according to Albert B. Stevens, professor of petroleum engineering at the college and chairman of the conference. It was sponsored by the Texas Petroleum Research Committee, and was well attended by representatives from several phases of the oil industry. The following papers were presented at the three-day meeting:

The Railroad Commission's Function in Increasing Oil Recovery, by W. J. Murray, Jr.

Significant Research Projects in Petroleum Recovery—Present and Future, by Harry H. Power.

What Increased Oil Recovery Might Mean to Texas, by Paul D. Torey.

The Return of Salt Water to the Wood Sand in the East Texas Oil Field, by W. S. Morris.

Controlling and Predetermining Secondary Recovery, by W. L. Horner.

Results of Oil Recovery Research at the Pennsylvania State College, by A. W. Gauger.

Theoretical Considerations in Secondary Recovery, by George H. Fancher.

Prediction of Secondary Recovery from Core Analyses, by R. C. Earlougher.

Results Obtained in Several Secondary Recovery Projects, by Paul and David Dean.

Permeability Effects in Secondary Recovery, by John C. Calhoun.

Gas Repressuring in Texas, by Roland Gouldy and R. F. Dobyns.

Burkburnett Field Water Flood Project, by Henry Holland.

Research on a Method of Determination of Water Flood by Electrical Resistivity Methods, by Harold G. Vanhorn and Richard S. Guenther.

A Review of Secondary Recovery in the United States, by Paul D. Torrey.

Behavior of Water Input Wells, by Kurt H. Andresen and Park A. Dickey.

Practical Aspects of Gas Cycling, by Martin G. Miller and Max Lentz.

Erle Daveler receives Certification of Honorary Membership from William Wrather at the Annual Banquet.

Biggest Technical Program Marks First Annual Meeting on Coast

REPORTED BY LEWIS A. PARSONS

Now that the 77th Annual Meeting of the AIME, and the first held in San Francisco, is over, there are few left who have not been convinced that a successful meeting can be held outside New York. This meeting is memorable not only because the technical program was the biggest in AIME history, but also because of the outstanding success of the many social events arranged to entertain visiting members and guests. Long-remembered by the 2000 in attendance will be the Annual Banquet, the All-Institute Luncheon, the St. Valentine's Day Dinner Dance, the Stag Smoker, the various Division lunches and dinners, and the well-attended program of the Woman's Auxiliary.

The ladies, perhaps, should be mentioned first, for without their charm and beauty none of the Institute events could have been as pleasant as they turned out to be. Under chairmanship of Mrs. H. Robinson Plate, the Woman's Auxiliary arranged a full program of its own. Attendance was extremely heavy, about 300, which was believed to be an all-time record for the Auxiliary.

The 1949 meeting reached its high point in the Annual Banquet which attracted 1065 members and their guests to the colorful Garden Court of San Francisco's historic Palace Hotel. It was there that the incoming and outgoing officers of AIME, together with the distinguished award winners, were honored by their fellow members. Before the Banquet began, there were two receptions for those who were later to be seated in places of honor on the dais. The warmth of heart and general conviviality brought much gaiety to the otherwise formal affair.

Robert Gordon Sproul, president of the University of California, gave an inspiring address stressing the great moral strength of the American way of life. Seating was arranged in tables of ten, each table graced by large sprays of western flowers. As a memento of the event, every lady present received a souvenir gold pan commemorating the California Gold Rush of 1849. Dancing began when the formal business of the evening was concluded, and many remained until two o'clock in the morning.

Attendance at 1949 Annual Meeting Compared to 1948

	1949 San Francisco	1948 New York
Men's registration.	1820	1804
Women's registration	338	226
Annual Banquet	1065	1125
Dinner-Smoker	462	845
All-Institute Luncheon	740	545
Informal Dance	575	522

The tremendous success of the entire social program was presaged on the first day of the meeting, when an overflow crowd gathered at the Fairmont Hotel to hear an address by Governor Earl Warren of California at the annual All-Institute Luncheon. Dr. Wrather introduced the guests at the speaker's table after which he presented William Wallace Mein, Jr., Chairman of the San Francisco Section and also of the Annual Meeting Committee, with a gold watch fob from the San Francisco Section in appreciation for his work in organizing the Annual Meeting. Next on the agenda was the announcement of winners of the Student Prize Paper Contest. W. E. Ellis, the only winner in attendance, received his award.

Governor Warren, in discussing the early history of California gold mining, said that the City of San Francisco was built by the gold miners and that in February of 1849 there were fewer women in San Francisco

Dancing after the formal banquet was fun and lasted until the wee small hours.

than presently attending the AIME meeting. To the amusement of everyone, he read an editorial from the *Engineering and Mining Journal*, commenting on a Regional Meeting held in San Francisco fifty years ago, which suggested that the pleasures of the meeting interfered with business and that these meetings might better be discontinued. The present-day AIME member seems to be able to take his technical sessions, hangovers notwithstanding.

That same evening, 575 enjoyed a St. Valentine's Day buffet dinner dance in the newly decorated Peacock Court at the Mark Hopkins Hotel. Music was by Ray Hackett's orchestra —a point of particular interest to mining men since Hackett got his start at one of the nation's well-known mining schools, the University of Nevada. The food, in the words of one happy delegate, was "beautiful to look at and wonderful to eat." California wines were placed on every table, and many Easterners became acquainted for the first time with the glorious bouquets developed by the vintners of the West. Excellent formal entertainment was provided in the main room during the course of the evening, but those in the back room, to whom this was not visible without leaving their tables, took things in their own hands. A group of well-known petroleum production men and their wives, arms entwined, stood around a table of long-haired beneficiation researchers and harmonized to the tune of "I Been Working on the Railroad."

Those who were lucky enough to attend are still talking about the Stag Smoker which was held in the San Francisco Commercial Club on the evening of Feb. 15. Professional entertainment was drawn from leading night clubs in the San Francisco area, but it took a pair of comparative amateurs to steal the show. The amateurs, Rip Borden and Phil Bradley, Jr., introduced a new scheme for national taxation which many delegates thought had excellent possibilities for development. So well received were their suggestions relative to Uncle Sam's excise taxes that they provided an encore in which the functions of the Institute's Board of Directors were explored.

On the same evening, the Petroleum Division held its Annual Dinner at the Fairmont Hotel. Reese Taylor, president of the Union Oil Co. of California, delivered an address entitled "The Greeks Had a Word for It." Petroleum Division Certificates of Service were presented to F. Julius Fohs and J. B. Umpleby. The Red Room, where the dinner was held, was filled to overflowing. Present, as indicated when called upon to take a bow, were many former chairmen of the Division and Institute officers, among the latter Directors Alford, Bowles, Millikan, Schumacher, and Suman. At the conclusion of the dinner Irwin W. Alcorn, Division Chairman, who presided, turned the gavel over to Lloyd E. Elkins, incoming Chairman for 1949.

In addition to the many Institute-sponsored affairs were numerous private cocktail parties. Notable among these was a function hosted by Dr. and Mrs. Frank Girard, Mr. and Mrs. Worthen Bradley, Mr. and Mrs. James Parks Bradley, and Mr. and Mrs. John D. Bradley, in the Girard home in Pacific Heights.

Section Delegates from forty Local Sections gathered on Monday for an all-day discussion of Institute affairs and the relation of the AIME to its members. The main problem discussed was the Institute deficit and the possibility of retiring it by raising dues. This situation was thoroughly aired during the entire morning meeting and during most of the afternoon. After due deliberation, the Section Delegates voted to recommend to the Board that, because of the serious financial plight of the Institute, appropriate steps should be taken to increase the annual dues of Members and Associate Members from $15 to $20, and of Junior Members from $10 to $12, effective for 1950 and for two years thereafter; further, that a referendum be taken in 1952 as to the dues for succeeding years in light of the financial position of the Institute at that time. It should be noted that "appropriate steps" will include a referendum of the members, as provided by the bylaws.

Among other important matters discussed was the proposal to hold fewer and longer Board meetings which would convene at various convenient points around the country. This would increase the importance of each meeting and increase Director attendance. Routine matters could be dealt with by the Executive and Finance Committees at monthly meetings, subject to approval later by the entire Board. The Delegates went on record in favor of this proposal.

Before adjournment the Delegates voted to express their appreciation to the San Francisco Section for their hospitality at this Annual Meeting and to thank Dr. Wrather for his outstanding service to the Institute as President in the difficult year just passed.

technical program

The technical program was bigger than ever before, being comprised of some 60 sessions covering all phases of the mineral industries. The unity and purpose of the Institute meetings were best expressed by the number of joint sessions between various Divisions. Outstanding examples of this joint interest were such sessions as the Minerals Beneficiation Division and the Iron and Steel Division on "Pyrolysis and Agglomeration"; and Extractive Metallurgy, Industrial Minerals, and Iron and Steel Divisions on "Titanium."

Educators convened on Sunday on the beautiful campus of the University of California in Berkeley for afternoon and evening sessions which were interrupted only by cocktails and a buffet supper. The other Divisions and Committees of the Institute began their technical programs on Monday, many lasting for the full four days. The Society of Economic Geologists met jointly on Tuesday and Wednesday with the Institute's Mining Geology Committee. As usual, Division and Committee luncheons served the joint purpose of satisfying the inner man and conducting the annual business meeting of the group. The luxurious dining rooms of the Fairmont, Mark Hopkins, Clift, and Bellevue Hotels provided attractive settings for these affairs. Numerous motion pictures, mostly through the courtesy of the Bureau of Mines, added interest to the technical sessions.

Affairs of the Metals Branch of the AIME were conspicuous in the program. There were 28 sessions, including technical papers, luncheons, and lectures. The number of papers was over 65 and usually the formal papers were followed by lively discussions. Nor were those who discussed papers shy in taking exception to theories presented.

One of the main events was the Institute of Metals Division lecture by Egon Orowan, Cavendish Laboratory, Cambridge, England, on "Structure of the Cold-worked Metal." Equally well-received was the Howe Memorial Lecture on "What Is Metallurgy?" by John Chipman, head, department of metallurgy, Massachusetts Institute of Technology. In place of the usual Institute of Metals Division dinner and the Iron and Steel Division luncheon, a successful Metals Branch luncheon attended by an even 100 inaugurated the formation of the Metals Branch.

The technical program of the Petroleum Division began on Monday afternoon with a review of foreign and domestic production. On Tuesday morning there were three papers on economics subjects and the Wednesday morning and afternoon sessions were devoted to petroleum technology. Mr. Elkins presided at the open session of the Executive Committee for 1949 on Thursday morning.

Detailed reports of the various Division and Committee technical sessions appear in Section 1 of the appropriate Branch journals.

An airplane trip over San Francisco was conducted on Wednesday and Thursday through the courtesy of Pan American Airways. V. L. Vanderhoof, of Stanford University, accompanied the trips and pointed out sights of cultural and industrial importance in addition to giving an interesting commentary on them.

Olaf P. Jenkins took about 23 in a Greyhound bus on a field trip to see the sights and geology around the Bay area. The day was bright and sunny and so everyone was in good spirits as the trip started across the Bay Bridge and toured the Berkeley Hills returning to Richmond on the ferry. An excellent luncheon was enjoyed at the Hamilton House in Fairfax. The party continued to Olema on the San Andreas fault and finally returned to San Francisco across the Golden Gate Bridge. Another trip was led by Edgar Bailey to study the geology of the New Almaden quicksilver area. Both of these trips were enjoyed by all who participated. About a dozen people signed up for the post-meeting trip to Hawaii which was a 6 to 10 day tour of the interesting points of the Islands. It will be a long time, if ever, before the many enjoyable experiences of the 1949 meeting in San Francisco are forgotten.

The general committee, headed by William Wallace Mein, Jr., the finance and banquet committees headed by Walter L. Penick, the entertainment and hospitality committee headed by Worthen Bradley, the reception committee headed by Richard D. Moody, the dinner-dance committee headed by P. R. Bradley, Jr., the stag smoker committee headed by Herbert A. Sawin, and the All-Institute luncheon committee headed by George H. Playter worked hard to make every event a success.

The San Francisco Section and the Institute as a whole acknowledge gratefully the contributions which so greatly helped in making this meeting possible. Among the contributors were:

Allis-Chalmers Manufacturing Co., American Brake Shoe Co., American Cyanamid Co., American Forge Co., American Rubber Manufacturing Co., American Smelting and Refining Co., Apache Powder Co.

Baroid Sales Division, National Lead Co., Bishop Oil Co., Bradley Mining Co., Braun-Knecht-Heimann Co., E. D. Bullard Co., Bunker Hill & Sullivan Mining and Concentrating Co.

Calaveras Cement Co., California Wire Cloth Corporation, Capital Co., Chicago Pneumatic Tool Co., Coast Manufacturing and Supply Co., Crucible Steel Co. of America.

Dorr Co.

Thomas A. Edison, Inc., Electric Steel Foundry Co., Electric Storage Battery Co., Empire-Star Mines Co.

Gardner-Denver Co., General Electric Co., Gold Hill Dredging Co., Goldfield Consolidated Mines Co., H. W. Gould & Co., Great Western Division, Dow Chemical Co.

Abbot A. Hanks, Inc., Hanna Coal and Ore Corp., Homestake Mining Co., Honolulu Oil Corp., Humphreys Investment Co., Hardinge Co.

Ingersoll-Rand Co.

Joy Manufacturing Co.

Kaiser Iron and Steel Co., Kennecott Copper Corp., Knob Hill Mines, Inc., Kennametal, Inc.

Link-Belt Co., Le Roi Co., Cleveland Division.

Marsman & Co., B. F. McDonald Co., McGraw-Hill Publishing Co., Merrill Co., Metal and Thermit Corp., Mine Safety Appliances Co.

Nevada-Massachusetts Co., Nordberg Manufacturing Co.

Oliver United Filters, Inc.

Pacific Coast Aggregates, Inc., Permanente Cement Co.

Quaker Pacific Rubber Co.

Shell Oil Co., Sonoma Quicksilver Mines, Inc., Sperry-Sun Well Surveying Co., Standard Oil Co. of California, Stephens-Adamson Mfg. Co.

Taylor-Wharton Iron and Steel Co., Tide Water Associated Oil Co., Timken Roller Bearing Co., Thurman Gold Dredging Co., Traylor Engineering and Manufacturing Co., Tyler Co., W. S.

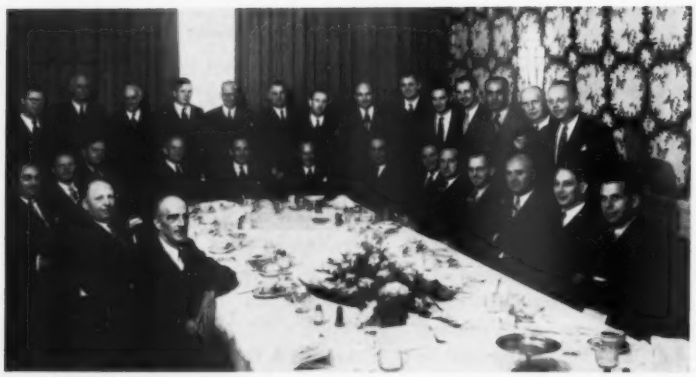
Union Pacific Coal Co., Utah Construction Co.

Western Precipitation Corp., Western Machinery Co., Westinghouse Electric Corp., Wildberg Bros. Smelting and Refining Co.

Yuba Manufacturing Co.

San Francisco drew a crowd for the Annual Meeting; here members register, meet old friends, and make new ones.

Seen at the Annual Meeting



But on Friday, before the clans gathered, some of the men responsible for the meeting's success attended a kick off luncheon.

With the meeting in full swing, Alice Fischer, only feminine metallurgist registered, meets President Young.

All-Institute luncheon fare was excellent (left) with Governor Warren (above) as pièce de résistance. L. E. Young and William Wrather are seated on either side.

A Don Loper original of imported lace embroidered in an overall fern pattern with silver threads modeled during the Woman's Auxiliary fashion show; lovely, isn't it.

Bain, McLaughlin, Fischer, and Page discuss atomic mineral deposits; (below) R. F. Davis speaks on petroleum refining at an MIED session, flanked by G. C. Gester and E. DeGolyer, moderator.

Dancing brings the Banquet to a pleasant close. It also marked the end of the formal social functions, but not the end of gatherings of friends in lobbies and corridors, and sightseeing in San Francisco. Thanks are certainly due to every one concerned with making the meeting a success.

Robert L. Hoss receives the Alfred Noble prize from President Wrather. (Below) James Boyd, E. H. Robie, and Earl Warren chat at the All-Institute luncheon.

Controversy on Mineral Supplies Marks Mineral Economics Session

O. P. Jenkins, W. T. Hannum, and Governor Warren talk over mineral supplies as W. E. Wrather smiles on the gathering.

REPORTED BY JOSEPH T. SINGEWALD, JR.

A national mineral policy symposium comprised four papers covering a survey of domestic deficiencies and potential foreign sources by Alan M. Bateman, a consideration of critical factors affecting the domestic mining industry by Otto Herres, Jr., a review of progress in stock piling by Richard J. Lund, and discussion of the role of government in a national mineral policy by Donald H. McLaughlin. Elmer W. Pehrson and Charles H. Behre, Jr., served as chairman. Though replete with fruitful thought, the symposium resulted in no definitive solution of the complex problems of to what degree and how and when our domestic resources should be drawn upon and to what degree our domestic resources should be conserved by drawing on foreign supplies. The incompatibility of maintaining a strong domestic mining industry and not depleting our reserves presented a baffling problem.

Bateman's paper was presented by Mr. Pehrson. The war demands increased the former dozen strategic minerals to five dozen, of which 27 came only from foreign countries. Our own demand for many of them exceeded the existing world supply. The postwar demand has remained at the wartime level. The author is more optimistic over our mineral resources than the estimates in "The Mineral Resources of the United States," but emphasized the urgent need for the United States to become more internationally minded in providing the mineral needs of the future. Realignment of the sources from which we can supply our deficiencies due to developments in the international situation were described, including the dropping of the "iron curtain," which has either shut off or made precarious some of our most important sources of the past. Thus private industry alone can no longer be relied upon to assure the United States adequate mineral supplies from abroad, but must be supported through diplomatic channels. H. DeWitt Smith cited wasted war effort to supply our needs of such metals as manganese from domestic sources to the neglect of adequate foreign sources.

Mr. Herres pointed out that our domestic mining industry is not as strong as the record 1948 dollar volume might suggest, because we are operating under both a peacetime and a wartime economy determined by political interests that are diluting our dollars. Weakening factors are: higher wages not compensated for by added production, high taxes that destroy venture capital, removal of tariff protection, and neglect of the mining industry by the planners who are determined to support many other things by government subsidy programs. He warned that we should heed the lesson of Europe, which amassed great wealth by selling goods to all the world only to waste its riches and resources in the devastation of war, by preserving our economic strength. Arthur Notman advocated conserving our limited resources and meeting current needs from the resources of our potential enemies, and Olaf Jenkins stressed the need to preserve stock piles for national defense instead of redistributing them as the threat of war decreases.

Richard Lund and Otto Herres at the symposium on national mineral policies.

Morris Muskat brings home a point at a MIED session. Also at the speaker's table are R. F. Davis, E. DeGolyer, A. C. Rubel, and C. A. Heiland.

Mr. Lund outlined the history of stock piling, the need for which was recognized during World War I and, although urged by the experts, was neglected during the 20's and 30's. Substantial progress was again made during World War II, but the lessons of that war were again forgotten, and sizable stocks of strategic materials were quickly legislated into peacetime consumption. The Berlin crisis forced a belated recognition that the stock pile is a high priority claimant. Stock piling was started over again so that by the end of 1948 all available funds had been spent or committed. Stock piling should not be restricted to foreign sources, but should include utilizing most economically low-grade domestic deposits. It was pointed out that in a future emergency, power will be a severe bottleneck, and it should be stored by stock piling metals rather than ores. Philip R. Bradley, Jr., advocated the development of self-sufficiency through the encouragement of a wide search for mineral deposits under favorable government policy rather than through the short-sighted policy of government subsidies. W. D. Johnston, Jr., cited the newly established Brazil-United States Technical Commission which is planning the development of vast iron and manganese resources in Brazil by private capital.

Dr. McLaughlin advocated a national mineral policy of free enterprise under reasonable control. He regarded subsidies as undesirable, but needed if profits are sucked by taxes to be redistributed according to bureaucratic social control. A guaranteed price would stimulate private enterprise at home, and government support is needed to increase foreign supplies. Both tax relief and financial aid cannot be had at the same time. He hoped that money and man power will not be wasted again, however, in searches for materials which we don't have. Though pleading for economy in government expenditures, he recognized the value of research and regional survey by the U. S. Geological Survey and the Bureau of Mines. Cooperation of government and industry in discovery during the war was approved, but the final steps of development should be left to industry. Ira Joralemon and Arthur Notman both endorsed his views. Though competitive free enterprise was accepted as the soundest national mineral policy a heavily-taxed mining industry was bound to lean to some extent on government aid.

Educators Discuss Effects of Research on Education Trends

REPORTED BY J. D. FORRESTER

Under the general leadership of its Chairman, Curtis L. Wilson, the Mineral Industry Education Division held three sessions in San Francisco and Berkeley during the 1949 Annual Meeting. Following the usual custom of meetings which are held by the Division, the first session began at 2:30 Sunday afternoon, Feb. 13, in the Hearst Mining Building of the University of California, Berkeley, and continued into Sunday evening, after cocktails at the Claremont Hotel and an excellent buffet supper at the Men's Faculty Club. The second and third sessions were comprised, respectively, of a technical program on Monday morning and a business meeting luncheon on Tuesday. Attendance at the different meetings was good and the interest maintained throughout the sessions was extraordinary. Eighty-five were present at the Sunday meeting, 40 members attended the Monday technical session, and 18 were present at the luncheon.

The general theme adopted for the Sunday sessions, which served as a guide for the formal speeches, was "Mineral Engineering Education of the Future in the Light of Present Day Research Problems." Several outstandingly informative talks were of-

fered on various aspects of the subject. David R. Mitchell read Dr. Lawall's paper, Fred C. Bond offered an analysis of F. T. Agthe's manuscript, and R. F. Davis read Dr. Egloff's paper. All other papers scheduled for the Sunday program were presented by their respective authors. As evidence of the capacity of the speakers and of the timeliness of the general topic, each of the contributions led to extensive discussion by the assembled members.

J. R. Van Pelt and Everette DeGolyer served, respectively, as moderators of the Sunday afternoon and evening sessions. They stressed the advancement made by industry through academic and industrial research and cited the importance of fundamental experimentation as demonstrated by the tone and caliber of the talks offered by the speakers of the forum.

The Monday morning program was held in the Mark Hopkins Hotel in San Francisco. Analyses were offered of curricula in various phases of mining and metallurgy, and statistical data of graduate and undergraduate enrollments in schools of the mineral industry were presented. Harry E. Nold's paper on registration of engineers was given by Dean Wilson and William B. Plank's and Edward Martinez's contribution was read by Robert T. Gallagher. All other papers were delivered by the respective authors.

At the luncheon-business meeting of the Division held in the Clift Hotel, it was announced, by Dean Wilson, that Messrs. Gallagher, Thomas L. Joseph, and Ben H. Parker had been elected to the Executive Committee of the Division. They will serve until February 1952. Other officers of the Mineral Industry Education Division will serve during 1948-49. In closing the business meeting Dean Wilson expressed his appreciation to all participants in the programs of the Division. He gave special thanks to Dr. Gallagher for his splendid service as Program Chairman and to Lester C. Uren and Carlton D. Hulin for their joint efforts as hosts of the Sunday meetings held on the University of California campus.

Students Question Industry on Prospects

REPORTED BY JOHN V. BEALL

Mineral industry students gathered, about seventy strong, from four different colleges at the annual meeting in San Francisco for the second in what is hoped will be a series of student forums at AIME meetings. The series started auspiciously at the El Paso Regional Meeting and continued in San Francisco in what would have been a rapid fire question and answer session if the answers were as easy to give as the questions were to ask. Schools represented were the University of California, Stanford, and the Universities of Nevada and Arizona. Jay Carpenter, of the University of Nevada, was moderator and was supported by "elders" (we don't know who thought up this term but everybody got a kick out of it) L. E. Young, representing coal; James A. Barr, Sr., industrial minerals; James A. Barr, Jr., research; Barney Haffner, metal mining; Richard Moody, manufacturing; Harold J. Clark, petroleum; and Ira Joralemon, mining geology.

supply jobs open

Professor Carpenter was introduced by Lawrence Wright, who, incidentally, can moderate for us anytime. Jay quickly found out who his audience was by a fast poll which elicited the following facts: most of the students were from the University of California; roughly 25 were miners, 25 petroleum engineers, the rest being split between geology and metallurgy; 50 per cent married; 70 per cent veterans; and lo! one lovely lady miner. Without further ado, Mr. Moody was given the floor to describe the training program of Allis-Chalmers which he said was not unlike those of Ingersoll Rand, General Electric, and Westinghouse. In brief, the course is 18 months long, with the applicant going to Milwaukee where he is processed through the shop, design, research, and sales departments during that period. An aptitude test is given to help him decide which of the fields he would like to follow; design, research, or sales. Starting pay is around $250 and is raised to $270 by the end of the course. While in training, a man can go on and take a master's degree. Mr. Moody pointed out that sales work was engineering because equipment is sold on its engineering merits, its ability to do a particular job; and therefore salesmen must be able to help customers with their engineering problems. These companies hire all types of engineers. Our lady miner, Mrs. L. R. Miller, asked if the course was open to women. Mr. Moody said that they had never had a woman take the course but he didn't see why one couldn't. Mr. Barr, Sr., volunteered that he had a woman chief of party and a chemist, both of whom had gotten along fine.

opportunities in large vs. small companies

The question was raised from the floor as to whether it was better for a graduate beginner to work for a big company or a small one. Barr, Sr., commented on his experience in starting with a small company, but moving shortly afterward to International Minerals and Chemical with which organization he has been ever since. His feeling was that a young man got more experience with a large company. On the other hand Mr. Barr, Jr., had moved 25 times in his early days with the idea of seeing as much as he possibly could. He thought this was a good procedure if you had a wife who could take this kind of treatment. He is now a research man

for Armour. Mr. Haffner, who is general manager for Bunker Hill & Sullivan, thought that a man should go with a large company where he can learn something and then size up the situation as opportunities for transfer occur. Mr. Haffner is an exponent of the young mining engineer starting in production. Mr. Joralemon was of the opposite inclination. In a small company you learn more as you have to do a little bit of everything.

Dr. Young, who is a coal mining consultant as well as President of the AIME, outlined the procedure followed by a progressive coal company with a recent graduate. The young man is put into production work, either being shifted through various production jobs, or put on time study, or safety. At the end of three years he should apply for a qualifying certificate from the state in which he is employed. Starting salaries are set equal to the rate paid by any other industry in the area. Dr. Young followed a policy, when he was managing, of raising the man $25 every six months if he was worth it or firing him if he couldn't make the grade. He was of the opinion that large companies had a better organized training program than small companies. Putting a man in the surveying department of a coal company was a mistake in Dr. Young's opinion as the work of that department has to do chiefly with reserves and property lines and requires an intimate knowledge of the company's holdings. Also there would not be an opportunity to learn production work in this department. Dr. Young explained that a young man must broaden his knowledge after graduation on his own initiative. He should study economics, labor relations, and government in order to build a background suitable for promotion to the higher echelons of company organization.

foreign work discussed

On the request of the students, the question of the advantages or disadvantages of foreign work were discussed by the "elders." Mr. Barr, Sr., said that it was a question of whether you wanted to stay abroad or not, as the opportunities for advancement were good if you remained abroad but on the other hand it was hard to get a comparable job in the States after you had been foreign for a while. Professor Carpenter opined that to get into pioneering you had to go abroad. The biggest problem in this sort of work, he maintained, was the frequently adverse living conditions. However, in his opinion, one did not lose contact with people at home. In a reminiscent frame of mind, Jay went on to say that students didn't go leasing these days as they did in the old days. Until you had gone bust on a lease you hadn't cut your teeth in the mining profession. This brought a chuckle from the "elders." There was a decided note of nostalgia for the romance of mining in the old days in this soliloquy. Jim Head, a Chile Exploration man, was asked for his opinion on foreign work. Jim said that he wouldn't take anything in exchange for his years abroad and the contacts he made were the pleasantest of his life. In explanation to the students of the difficulties in taking one's wife abroad which is prevalent with many companies, he stated that housing was short and the mining companies were working to remedy this situation. As a word of caution, Mr. Head said that there was no quick road to the top in the mining industry.

advanced degrees depend on individual

The question of whether a man should work for an advanced degree or not was raised and Dr. Young replied that if the man was going into production work, he should get some experience first. Joseph T. Singewald, Jr., professor of economic geology at Johns Hopkins, suggested that field work was essential for a student who wished to take an advanced degree in geology. However, this work could be done during the summer with the USGS or with operating companies while the man was completing his course.

Opportunities for geologists in exploration were outlined in response to questions raised by the students. Mr. Joralemon said that they were excellent, particularly in foreign exploration, as so few men are willing to go. He pointed out that a good man can make just as big a name for himself abroad as by working at home. Mr. Haffner said that they used geologists at Bunker Hill and that the attitude of operators toward geologists has changed in recent years. Formerly the operator thought the geologist was only good for telling how the ore got there after the operator mined it. Mr. Haffner went on to say that most mines now used geologists to aid in development and that at his mine $300 was the starting salary.

older students not at disadvantage

Since most of the students were veterans of World War II, their average age was higher than in normal years. Hence the question was raised as to whether these older men were at a disadvantage after graduation. Professor Carpenter answered this pertinent question by assuring them that their wartime experience in human relations and handling men more than made up for their late start in industry.

S. S. Arentz, general superintendent at Pioche for the Combined Metals Reduction Co., wound up the meeting with a few amusing anecdotes from his experience as a mine operator which pointed up the fact that understanding the miners was the operator's most important job and the best way to learn to do this was to work as a miner.

Scholarships from Coal Industry

Scholarship awarding has been added to the ever-growing activities of the bituminous coal industry. Various coal companies and associations who want to improve mining community life and create a pool of available engineering personnel for the bituminous coal industry are currently providing 94 college scholarships. Among the seventeen organizations offering the scholarships are the Central Appalachian Section of AIME, with three, and the Coal Division of AIME, with two.

Jane Rees models an embroidered lace evening dress at the fashion show sponsored by the Woman's Auxiliary.

Woman's Auxiliary Enjoys San Francisco's Hospitality and Social Events

REPORTED BY MRS. E. H. ROBIE

Setting a standard of hospitality that will be difficult to equal, the committees of the Woman's Auxiliary under the efficient direction of Mrs. H. Robinson Plate, with the generous financial and personal support of the San Francisco Section, planned and carried out a successful program of entertainment for the ladies at the Annual Meeting of the AIME.

On Sunday evening, Feb. 13, the first social gathering, a cocktail party in the spacious home of Dr. and Mrs. Frank Girard, gave over 400 members a pleasant opportunity to meet old friends.

Monday morning 288 women registered in the lobby of the Fairmont Hotel. Most of the ladies decided not to miss any of the interesting affairs scheduled for their entertainment.

Governor Warren of California held the attention of those who attended the All-Institute Luncheon on Monday. It is easy to understand why he is the choice of both Democrats and Republicans in his home state.

Monday evening the Informal Dinner Dance in the artistic Peacock Court of the Mark Hopkins Hotel was a great success. Guests were seated at small tables lighted by hurricane lamps and served themselves at the buffet supper placed at one side of the room. The food was so artistically prepared and arranged that it was an added decorative feature. Amusing entertainers appeared during the evening and a fine orchestra made dancing a pleasure.

The Annual Meeting of the Auxiliary on Tuesday morning at the Mark Hopkins Hotel, presided over by the president, Mrs. Thorne E. Lloyd, was notable for its brief informative section reports under the direction of Mrs. H. A. Prosser. Lewis E. Young, President of AIME for 1949, addressed the meeting briefly, emphasizing the value of the work of the Auxiliary especially in the field of educational scholarships. A number of young, brilliant men whom he has known have been able, through these scholarships, to prepare for engineering careers.

Mrs. H. W. Hardinge, Chairman of the Chest Committee, reported briefly on the National project, the rehabilitation work under Howard Rusk at the New York Hospital.

Luncheon at the Top of the Mark followed. From the glass enclosed observation tower, the harbor, the Oakland and Golden Gate Bridges, and much of San Francisco can be viewed. It is a favorite spot at the cocktail hour when the colors of the setting sun fade and in the twilight that follows the twinkling lights of the city give a jeweled outline to bridges, buildings, and landscape below.

After luncheon we were driven by bus and private cars to tea at the home of Mr. and Mrs. W. W. Mein. This beautiful residence, set in the hills on the peninsula beyond San Mateo, was designed by Sir Herbert Baker the architect who planned the home of Cecil Rhodes in South Africa.

On Wednesday Mrs. Newell Alford conducted an interesting round table discussion in the Bonanza Room at the Mark Hopkins Hotel. A number of helpful ideas were brought out. Emphasis on the personal approach in Auxiliary affairs was stressed. Some membership chairmen telephone prospective members and many write personal letters. It was suggested that new members be appointed to working committees, also that older members make a special effort to talk to new members at meetings and so make them feel like part of the group. The round table was followed by a luncheon fashion show at the St. Francis Yacht Club where attractive mod-

els displayed the smart clothes so well that many guests hurried to The White House to get first choice of the well designed costumes. Buses and cars carried the guests back to San Francisco past the Yacht Basin to the Fairmont Hotel, a distance of five miles.

The Palace Hotel was the setting for the Annual Banquet Wednesday evening where a delicious dinner was served. President Wrather presented the special awards and medals and greeted Dr. Young as President of AIME for 1949. The ladies were presented with attractive silver pins in the shape of a miniature California gold pan, the gift of the contributors to the Annual Meeting entertainment fund. This favor appropriately marked the centennial celebration of the discovery of gold in California. Robert G. Sproul, president of the University of California, made the address of the evening. Dancing followed the formal ceremonies and many stayed until one a.m. to enjoy the last strains of the orchestra.

Although the banquet marked the end of formal social functions the corridors and lobbies of the hotels were filled with friends on Thursday and Friday. These last two days afforded time for trips to the attractive shops, to Chinatown, Fisherman's Wharf, and to the homes of friends. A number of fortunate women accompanied their husbands by plane to Honolulu.

Those who traveled by train through the snow blocked area of the middle west will recall the difficulties in reaching the Golden State of California in 1949. Many will remember the superb views of San Francisco, the cable cars, the cosmopolitan atmosphere of gayety, Chinatown, the fog that often blanketed the streets and muted the sounds of whistles from the harbor, all of which made their unique contribution to the setting for this successful Annual Meeting.

Woman's Auxiliary Girls Loan Fund Successful

A total of twelve girls have been put through school in the past eighteen years by the Girls Activities Loan Fund of the Women's Auxiliary, New York Section, AIME, and yet the original gift of $5000 remains untouched. The fund has $250 a year on hand to enable daughters of anyone, living or dead, associated with mining or metallurgy, to obtain a practical education which will prepare them to earn a livelihood. Recipients agree to repay one-half of the loan, and thus far eight of the twelve girls have done so. Expert management has enabled the ladies to pay out nearly $5000, and yet keep the original gift in the bank, in the form of stock. The New York Section's Women's Auxiliary will be glad to answer queries, and receive suggestions as to possible recipients.

Calendar of Coming Meetings

APRIL

1 **Columbia Section, AIME.**
4 **Boston Section, AIME.**
5-6 **Metal Powder Assn., 5th annual meeting and exhibit, Drake Hotel, Chicago.**
6 **Chicago Section, AIME. Continuous casting at B&W Tube Co.**
6-10 AIChE, regional meeting, Los Angeles.
7 **Reno Branch, Nevada Section, AIME.**
11 **Mid-Continent Section, AIME.**
11-14 National Assn. of Corrosion Engineers, 5th Annual Conference and Exhibition, Netherland-Plaza, Cincinnati.
11-15 **Western Metal Congress & Exposition, Los Angeles, Calif., AIME and ASM, etc.**
11-12 American Zinc Institute, annual meeting, Hotel Statler, St. Louis.
12 **East Texas Section, AIME.**
13 **El Paso Metals Section, AIME.**
13 **San Francisco Section, AIME.**
13 **Southwestern New Mexico Section, AIME.**
15 **Oregon Section, AIME.**
18 **Detroit Section, AIME. W. L. Grube on the electron microscope.**
18-20 Midwest Power Conference, Sherman Hotel, Chicago.
18-20 **Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference, Palmer House, Chicago.**
19 **Gulf Coast Section, AIME.**
19 **Washington, D. C., Section, AIME.**
19-21 AIEE, Southwest district meeting, Baker Hotel, Dallas.
20 **Southwest Texas Section, AIME.**
20-23 ASCE, spring meeting, Oklahoma City.
21 **Carlsbad Potash Section, AIME.**
21 **North Pacific Section, AIME.**
21 **Utah Section, AIME.**
22-23 **New England Institute of Metals Division Regional Meeting, Hotel Sheraton, Springfield, Mass.**
22-23 Engineers' Day, Colorado School of Mines, Golden.
24-28 **American Ceramic Society, national meeting, Netherland-Plaza, Cincinnati, Ohio.**
25-27 Canadian Institute of Mining and Metallurgy, annual meeting, Windsor Hotel, Montreal.
25 **Alaska Section, AIME.**
26 **Montana Section, AIME.**

MAY

2-4 ASME spring meeting, New London, Conn.
2-5 **American Foundrymen's Society, 53rd annual meeting, St. Louis.**
6-7 American Institute of Chemists, annual meeting, Chicago.
8-12 AICE, Tulsa, Oklahoma.
9-12 American Mining Congress, coal convention and exposition, Public Auditorium, Cleveland.
11-13 **Engineering Institute of Canada annual meeting with International Management Congress hemisphere meeting, Chateau Frontenac, Quebec.**
14 **Northwest Industrial Minerals Conference under auspices of Columbia Section, AIME, Spokane.**
May 16-June 3 U.N. Scientific Conference on Conservation and Utilization of Resources, New York.
25 **Iron and Steel Division, AIME, annual May dinner, Engineers Club, New York City.**
25-26 American Iron and Steel Institute, general meeting, New York City.

JUNE

16 **Engineering Foundation, 29 W. 39 St., New York City.**
June 27-July 1 **ASTM, 52nd annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.**
20-22 American Society of Heating and Ventilating Engineers, semi-annual meeting, Minneapolis, Minn.
20-24 **AIEE, summer general meeting, New Ocean House, Swampscott, Mass.**

JULY

9-23 Fourth **Empire Mining and Metallurgical Congress, Great Britain.**
13-15 American Society of Civil Engineers, summer convention, Mexico City.
15-24 Pan-American Engineering Congress, Rio de Janeiro.

AUGUST

23-26 AIEE Pacific general meeting, Fairmont Hotel, San Francisco.

SEPTEMBER

25-28 **Regional Meeting, AIME, Neil House, Columbus, Ohio.**
25-28 American Mining Congress, Western fall meeting, Spokane.
29-Oct. 1 Colorado School of Mines, 75th anniversary celebration.
Sept. 30-Oct. 1 Southern Ohio Section of Open Hearth Committee, AIME, fall meeting, Deshler-Wallick Hotel, Columbus.

OCTOBER

5-7 **Petroleum Branch, AIME, fall meeting, Plaza Hotel, San Antonio, Texas.**
17-19 **Institute of Metals Division, AIME, fall meeting, Allerton Hotel, Cleveland.**
17-23 AIEE, 1949 Mid-West meeting, Netherlands-Plaza, Cincinnati.
28 **Pittsburgh Section of Open Hearth Committee and Pittsburgh Section, AIME, annual fall meeting, William Penn Hotel, Pittsburgh.**

NOVEMBER

1-5 Pacific Chemical Exposition, California Section, American Chemical Society, San Francisco Civic Auditorium.
2-4 American Society of Civil Engineers, fall meeting, Washington, D. C.
7-10 AIChE, annual meeting, Pittsburgh, Pa.
12-14 Geological Society of America, annual meeting, Hotel Cortez, El Paso.

DECEMBER

8-10 **Seventh Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.**

FEBRUARY 1950

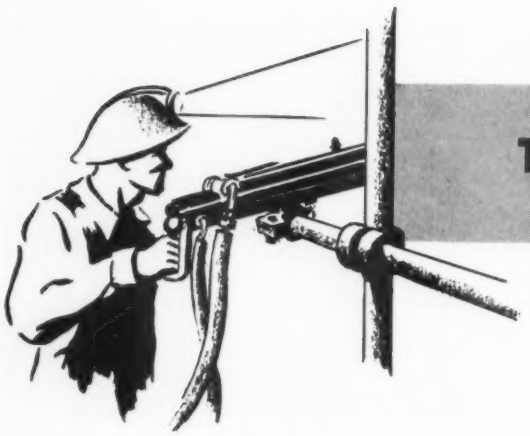
12-16 **Annual Meeting, AIME, Statler (Pennsylvania) Hotel, New York City.**

APRIL 1950

10-12 **Open Hearth Conference, and Blast Furnace, Coke Oven and Raw Materials Conference, Netherland-Plaza Hotel, Cincinnati.**

DECEMBER 1950

7-9 **Eighth Annual Conference, Electric Furnace Steel Committee, Iron and Steel Division, AIME, Hotel William Penn, Pittsburgh.**



THE DRIFT OF THINGS

. . . as followed by EDWARD H. ROBIE

A "Have-Not" Nation

Palestine, and the new state of Israel, have been much in the news in the last year or two, but little has been said about its natural resources. We were therefore interested in a lecture given by S. H. Shaw not long ago before the Imperial Institute on the geology and mineral resources of the country. Briefly, we gather that whatever they have been fighting about in that part of the world, mineral wealth is not a consideration, as it is in so much of the world's strife.

The area of Palestine is only 10,400 sq mi—about that of Maryland or New Hampshire, and one tenth the size of Arizona, for instance—and of that a third is the southern desert or wilderness zone, roughly in Negeb and the part of the country to the south of it. Palestine is long and narrow—260 miles long, and the maximum width, between the Mediterranean and the Dead Sea, is 70 mi. It has three distinct topographical zones or strips running north and south — the coastal plain, the hill country, and the Dead Sea rift valley. It is practically all sedimentary country, not older than Cretaceous, with the hill country made up of hard and well-bedded Cretaceous and Eocene limestones, chalks, and dolomites. Pre-Cambrian country is limited to a few square miles at the southern tip, where micaceous schists and granite occur.

The most important mineral to the economy of the country is water, but there is not much of it over most of the area. Surface supplies are scanty almost everywhere, and in the arid parts of the country to the south water is practically unobtainable. Supplies are extremely scant in the hill country as well.

But the greatest mineral resource of Palestine lies in the water of the Dead Sea, which contains about 27 per cent of mineral matter, chiefly the chlorides of magnesium, sodium, calcium, and potassium, in that order, and magnesium bromide. Palestine Potash Ltd. has extensive treatment plants and produces potash, bromine, and salt, with plenty of magnesium chloride also available if anybody wants it.

The dolomitic limestones are extensively quarried for building stone, lime-burning, road stone, brick, and cement making, and use as a soil conditioner. Rock salt is obtained from solar evaporation of sea water as well as from treating the Dead Sea brine, and immense deposits can be mined if needed.

That about sums up the mineral resources. A little feldspar and barytes have been found, and unpromising deposits of sulphur, phosphate, manganese, and even copper are known. Three areas have possibilities of oil—the coastal plain, the Negeb, and the southern end of the Dead Sea, the last-named perhaps being the most promising, for bituminous limestones are present, which characterize so many of the oil fields of the Near East. A salt mountain exists here but it is perhaps not what oil men think of as a salt dome, for bedding exists in the salt, conforming with that of the sediments. But its presence does indicate the possibility of suitable structural traps for the accumulation of oil, although the faulted nature of the area may indicate that any oil has been dissipated rather than conserved. Exploration is going on.

Lack of mineral resources is always a handicap to a nation, though not a critical one, as many small nations have proved. The Jews are sufficiently resourceful and talented to find ways to make a living other than by the exploitation of mineral resources.

What Are Profits?

Proponents of wage increases for union labor, confronted with the argument that such wage increases will immediately be offset by higher prices, thus continuing the inflation spiral, reply that higher wages can easily be paid out of swollen profits and if capital would only be satisfied with a normal profit, no increase in prices would be necessary. It is true that profits of many if not most companies have been considerably greater than what might be considered normal, and that dividends have been consequently higher, but it is often forgotten that these profits and dividends are expressed in dollars and the dollar is now worth only sixty cents, or thereabouts. By the same argument, wages should revert back to the prewar scale.

We had in mind continuing on this subject for a paragraph or two or three when we ran upon a statement made by our own Joseph E. Pogue before a Congressional subcommittee on business profits, entitled "The Function of Profits in the Petroleum Industry." He states the matter much better than we could, and furthermore this is Washington's Birthday and we shouldn't have to work.

"The term profits," says Dr. Pogue,

"is a popular expression, the technical counterpart of which is 'net income.' Net income, or profit, however, at best is an accounting interpretation or abstraction, not a reality or tangible quantity such as 'cash in the till.' According to accounting practice, it is determined by taking the total income received by an enterprise and deducting the operating expenses and taxes, and then subtracting an *estimate* of the extent to which the capital assets employed have been extinguished; that is, worn out and used up. The sum thus set aside out of the total cash produced is supposed to be sufficient to replace the facilities of the business so that it can continue as a going concern. It is obvious that the adequacy of the sum thus set aside for replacement determines the reality of the reported net income. It is equally clear that 'profits,' depending for their computation on an estimate, are themselves not an absolute quantity.

"There are four basic conditions which should be clearly held in mind by anyone seeking to analyze the size and significance of profits. I shall try to define these four principles and then briefly illustrate each point by data taken from our study of 30 oil companies.

"(1) In times of inflation, or rapid change in the purchasing power of the dollar, 'profits' as reported on the basis of established accounting practice are in effect overstated by the amount of the rise in replacement costs over the sum set aside to cover capital extinguishments — depreciation, depletion, and the like.

"(2) In times of inflation, reported 'profits' cannot properly be compared with previous years because of the shrinkage in the purchasing power of the dollar. Only by correcting for the changing length of the yardstick can this be done with any semblance of accuracy.

"(3) In times of inflation, the rate of return on the capital employed, ordinarily a very useful standard, cannot be used as a criterion of the magnitude of profits because the rate of return is a ratio between two sets of dollars of different values. It is a mathematical error to strike a ratio between things of a different kind. Only by adjusting either the capital employed or else the 'profits' to like dollars is such a ratio permissive.

"(4) In all times, inflationary or normal, the most effective criterion to apply in the judgment of 'profits' is their adequacy or inadequacy in the process of capital formation. Our entire economy is dependent upon the formation of sufficient capital funds to maintain and expand the country's productive capacity. As capital costs rise, 'profits' are called upon to supply increasing amounts of these funds.

"The reported net income of thirty oil companies was $763,000,000 in 1946 and $1,219,000,000 in 1947, an increase of $456,000,000, or 60 per cent. On the face of it, this increase appears large. But the charges for capital extinguishments (depreciation, depletion, etc.), designed to recover the capital funds extinguished during the year, were inadequate to replace the physical counterpart of this capital at prevailing higher costs. 'Profits' were therefore called upon to make up the discrepancy and part of the reported total was diverted to this purpose. Thus 'profits' computed by accounting procedure were larger than *de facto* profits. In other words, the *increased* cost of replacement appeared on the books as a profit."

Better Gasoline

Postwar motor fuels are much superior to the wartime grade, as every motorist has found by experience; they are also better than the prewar quality, and are getting better all the time. This statement refers primarily to the antiknock characteristics, which, to the average motorist, is the best index of quality. The latest Bureau of Mines report, based on samples taken last summer, indicates that the octane rating of first-grade gasoline (known as "ethyl gas") in various sections of the country varied from an average of 77.7 in the central plains area, where they don't have mountains to climb, to 82.1 in the Pacific Northwest, the countrywide average being 79.5. Second-grade (or "regular gas") varied from 72.8 in the South Mountain States to 77.3 in the Mid-Atlantic and New England States, the national average being 75.2 This compares with an average of 75.1 in the summer of 1947 and 74.4 in 1946. The premium grade figure of 79.5 in 1948 compared with 79.2 the previous summer, 78.3 in 1946, and 74.9 in 1945. In other words, the so-called regular grade of gas we are now getting is better than the ethyl grade we were offered in 1945. However, the compression ratio of automobile engines is increasing, which means they must have a gasoline of higher octane rating in order not to knock. If the compression ratio were greatly increased the engines would be much more efficient, but would require a gasoline with an octane rating of something like 100, as do airplane engines, and that would cost enough more to offset the increased efficiency, in whole or in part.

The Bureau's figures do not distinguish between the different brands as to octane ratings, which information would, of course, help motorists in gauging the relative qualities of the various gasolines offered.

If a motor knocks, however, it is not usually necessary to buy a more expensive gasoline to make it run quietly—a simple adjustment in the vacuum line, or an adjustment of the spark may be all that is necessary. In other words, the motor may be adjusted to the gas, as well as the gas selected for the motor.

Better quality of motor fuels and lubricants year by year, as well as a plentiful and comparatively cheap supply compared with many other commodities, is something for which the owners of some 40,000,000 American cars can thank the petroleum industry.

Embarrassing Moment

Nothing recently has been a greater surprise to us than when, in browsing through the March issue, we came to page 74 of the All-Institute Section. This page had been carefully concealed from us until the issue appeared, and the preliminary work had been done during our absence in San Francisco. For seventeen years we have been successful in keeping even our picture out of the paper, and now they do this to us. Immediately after concocting this, Frank Sisco had the good sense to make plans to leave the country, and when that issue reached its readers, he was well on his way to an unknown spot in South America.

ALL INSTITUTE SECTION

APPEARING IN:
- MINING ENGINEERING
- JOURNAL OF METALS
- JOURNAL OF PETROLEUM TECHNOLOGY

New Board Meets for the First Time in San Francisco

Twenty-five of the 36 Directors of the Institute were on hand for the Board meeting held during the Annual Meeting of the Institute in San Francisco, on Tuesday, Feb. 15, immediately following the annual business meeting, when the newly elected officers and Directors took their seats. Of the new group, L. E. Young, William Coulter, Lloyd E. Elkins, James L. Head, Howard A. Meyerhoff, E. R. Price, Frederick N. Rhines, John D. Sullivan, and George P. Swift were present. President Young presided for the first time. Most interest centered on a resolution drawn up by the Section Delegates after extended discussion at two sessions the day before, when they voted, 31 to 6, that the Board should consider raising the dues of Members and Associate Members from $15 to $20, and of Junior Members from $10 to $12, for the next three years, at which time a referendum would be taken as to whether or not the increase should be continued. The hope is that in three years the accumulated deficit of the last two or three years can be wiped out and that advertising income will be sufficient by that time to supplement the income from dues at the present rate so that the budget can be balanced. The Board voted to accept the resolution of the Section Delegates and to take the necessary steps to make an increase in dues for 1950 effective. This will involve a change in the by-laws and a referendum of the voting membership in the United States, Canada, and Mexico. Data to show why the increase is necessary if the present services of the Institute are to be continued or expanded will be supplied to all Institute members before the referendum is taken.

Much interest was also shown in the report of the Committee on Democratization, Joseph L. Gillson, chairman, with George Corless and E. A. Anderson. Dr. Gillson distributed copies of his report to all Directors present, and discussed his findings in some detail. The six principal recommendations were stated in the report of the January Board meeting on p. 137 of Sec. 2 of the March issue of this journal. The Board accepted the report with thanks, with the promise that such of its recommendations as can be financed will be put in force if found desirable by the Directors after study. A report of such study is to be made at the April meeting of the Board, at which time a further report from Dr. Gillson's committee was also invited.

Attention was called to the fact that at its meeting in November 1947 the Board had decided not to issue an AIME Directory in 1949 and that action was approved by the 1949 Board because of the expense that would be involved. The 1948 Directory had cost $14,000, and printing costs have since risen. A list of all officers, committee personnel, and other newly revised matter will be published in Section 2 of the monthly journals during the spring.

Authorization was voted to proceed with a new and completely revised edition of "Coal Preparation" which has recently become out of print. David R. Mitchell will again be the editor and it is hoped that the book can be published before the end of the year. An additional amount of $6000 was also appropriated from the Seeley W. Mudd Fund for the new edition of "Industrial Minerals and Rocks," supplementing the original appropriation of $10,000. Typesetting on the revised book is now well along and the volume should be ready early in the fall. A request that some 2000 copies of the recently published book by Robert E. Hardwicke on the effect of antitrust laws on the unit operation of oil and gas pools be distributed to libraries will be considered further at the March meeting.

Six major awards were authorized for presentation at the Annual Meeting in 1950 if the respective committees can agree on candidates. They are the Rand, Saunders, Douglas, Lucas, and Ramsay medals, and the Richards award. The committee will

Attendance at Meeting of Directors, February 15, 1949

Directors

L. E. YOUNG, President, who presided

Newell G. Alford
C. H. Benedict
Arthur J. Blair
Oliver Bowles
William E. Brewster
William J. Coulter
Erle V. Daveler
Lloyd E. Elkins
J. B. Haffner
James L. Head
Philip Kraft
William Wallace Mein, Sr.
Howard A. Meyerhoff
C. V. Millikan
E. R. Price
Frederick N. Rhines
E. E. Schumacher
John D. Sullivan
George P. Swift
R. W. Thomas
C. P. Watson
C. E. Weed
Curtis L. Wilson
W. E. Wrather

David C. Minton, Jr., alternate for Clyde Williams
Benton F. Murphy, alternate for Andrew Fletcher

Staff and Guests

D. W. Akins, Jr.
Joe B. Alford
R. H. Allen
Kenneth H. Anderson
Paul Andrews
S. S. Arentz, Jr.
Clayton G. Ball
R. J. Bethancourt
Stuart E. Buckley
H. M. Cooley
L. F. Elkins
G. H. Enzian
Norman D. Fitz-Gerald
P. E. Fitzgerald
Herbert A. Franke
O. B. J. Fraser
Thomas C. Frick
C. Y. Garber
Joseph L. Gillson
M. L. Haider
J. P. Hammond
Ray A. Hancock
Don L. Harlan
P. D. I. Honeyman
Elmer R. Kaiser
E. J. Kennedy, Jr.
Harold A. Krueger
J. C. Landenberger, Jr.
Carleton C. Long
William Wallace Mein, Jr.
Bennie G. Messer
V. J. Mercier
Harvey S. Mudd
Henry T. Mudd
W. A. Mueller
John F. Myers
F. M. Nelson
Russell B. Paul
H. S. Peterson
L. F. Reinartz
Edward H. Robie
H. A. Sawin
Dean H. Sheldon
A. A. Smith, Jr.
Joe P. Smith
Richard W. Smith
W. A. Sterling
W. R. Storms
William H. Strang
Landon F. Strobel
Linwood Thiessen
F. E. Van Voris
H. Y. Walker

welcome suggestions as to the names of men deserving the honors.

Chairmen of certain new standing committees of the Institute were named, the complete list to be announced at the March meeting.

Dates for the next four meetings of the Board of Directors were set as follows, each date falling on a Wednesday: March 16, April 20, May 18, and June 15.

At the request of Dr. Rhines, consideration was given to the proposal that a publication manager, or advertising manager, be secured to promote advertising in the new journals, as suggested by the Johnson Committee. Discussion at some length is planned for the March meeting of the Board and in the meantime Mr. Schumacher, with two other committee members to be selected by him, will study the advertising situation in respect to the *Journal of Metals*.

An Affiliated Student Society, comprising a group of students majoring in geology at the University of Wichita, was recognized. J. R. Berg is Faculty Sponsor and Edward A. Koester, Counselor.

The open meeting of the Board was preceded by an executive session at which the personnel of the Executive and Finance Committees for the coming year were named as follows:

Executive Committee

L. E. Young, chairman
Donald H. McLaughlin, vice-chairman
A. B. Kinzel
Earle E. Schumacher
John R. Suman

Finance Committee

Erle V. Daveler, chairman
Philip Kraft
Clyde E. Weed

Andrew Fletcher was unanimously re-elected Treasurer for the ensuing year, and Edward H. Robie, who had been Acting Secretary since Sept. 1 last, was elected Secretary.

Among the Student Associates

City College of New York

The Student Chapter at CCNY met on Jan. 14 to fill the offices left vacant by graduations. Herbert Feely is the new President; Jack Tarr became Vice-President; Julius Jettelson was named Secretary; and Seymour Feerst is Treasurer.—*Herbert Feely, President.*

University of Nevada

The Crucible Club of the Mackay School of Mines ended the year 1948 with publication of their semi-annual "Mackay Miner", and two interesting sessions with prominent guest speakers. Don White, Bureau of Mines geologist, spoke on Dec. 3, illustrating his topic "Volcanoes, Hotsprings and Ore Deposits" with slides. W. H. Denning, of the United Geophysical Co., was the year's final speaker, accenting new geophysical methods of finding oil in Brazil, and emphasizing the opportunities in geophysics which await young graduates.

The Club requests former students and graduates to forward their current addresses for the "Mackay Miner" mailing list.—*William D. Williams, Secretary.*

Illinois Institute of Technology

Forty-five members of the Illinois Institute of Technology Chapter of AIME have just completed their first, and highly successful semester at the school. Under the aegis of President Edward Murway, a weekly program of movies and guest speakers was followed, and the Chapter also managed to find time to put a basketball and volleyball team into intramural competition.

Edward Lever, Vice-President; Robert Domagla, Secretary; and Treasurer John Cordes, will hold down those positions, along with President Edward Murway, until June elections. T. S. Washburn, of Inland Steel, is the Chapter's Counselor. Both he and H. M. St. John, of the Crane Co., have addressed the Tech Chapter. Otto Zmeskal and Lucio Mondolfo are Faculty Sponsors.—*Robert Domagla, Secretary.*

Oregon State College

The Student Chapter at Oregon State College was reactivated in January, and new officers were elected at an informal meeting. Ronald F. Robberson will henceforth wield the gavel, and James G. Osborne, Jr., is Secretary. Dr. Ira S. Allison remains as Faculty Sponsor.

The Chapter's new Counselor, F. W. Libbey, director of Oregon's Department of Geology and Mineral Industries, who spoke at the group's first formal meeting, found many interested listeners to his talk on bauxite occurrences in northwestern Oregon.—*James G. Osborne, Jr., Secretary.*

What Went on at Recent Local Section Meetings

SECTION	DATE	PLACE	PRESIDING OFFICER	ATTEND-ANCE	SPEAKER, AFFILIATION, AND SUBJECT
Arizona, Ajo Subsection	Feb. 2	Ajo	William Keener	23	Jack Sheridan, Chile Copper Co., on Mining at Chiquicamata.
Boston	Feb. 7	Smith House, Cambridge	George P. Swift	65	J. N. Hobstetter, Harvard Univ., on Diffusion in Metals.
Carlsbad Potash	Feb. 17	Carlsbad	G. E. Atwood	58	John A. Frost, USGS, "Down the Colorado With Homemade Boat & Kodachrome."
Chicago	Feb. 2	Chicago	T. S. Washburn	123	S. J. Creswell, Carnegie-Illinois Steel Corp., on Recent Developments of the Bessemer Process.
Cleveland	Jan. 13	University Club	John M. Kiefer		Carl F. Prutton, Lubrizol Corp., on Lubrication and Lubricant Research.
Columbia	Feb. 4	Davenport Hotel, Spokane	Howard Sherman	28	Eugene Roberts, Merrill, Lynch, Pierce, Fenner and Beane, on Money at Work.
Connecticut	Feb. 9	Waterbury	R S. French	40	R. D. Heidenreich, Bell Telephone Laboratories, on Electron Microscopy and Electron Diffraction.
Delta, Mississippi Subsection	Jan. 28	Jackson, Miss.	W. W. Ramseur	55	H. G. Dewey, Jr., Chief, Miss. Basin Branch, Waterways Experiment Station, on The Waterways Experiment Station.
El Paso Metals	Feb. 9	Hotel Cortez, El Paso	Edward M. Tittman	39	W. D. Sydnor, Jr., Guided Missile Dept., Fort Bliss, Texas, on The Principle of Jet Propulsion.
Kansas	Feb. 9	Great Bend, Kans.	V. J. Mercier	85	Roscoe Clark, Stanolind Oil & Gas Co., on Proper Cementing of Casing.
Mid-Continent	Feb. 14	Tulsa, Okla.	John P. Hammond	62	Jack Webber, Atlantic Refining Co., on Hydraulics in the Use of Oil Well Packers.
North Pacific	Jan. 20	University of Washington	Kenneth H. Anderson	95	Ralph A. Sherman, Assistant Director, Battelle Institute, on Fuels for Today and Tomorrow.
Southeast, Florida Subsection	Nov. 1	Bartow, Fla.	E. S. Beebe		W. H. Twenhofel, Emeritus Professor, Univ. of Wisconsin, on Sedimentation. Dr. Rodgers, Stanford Univ.
Southeast	Jan. 19	Molton Hotel, Birmingham	J. C. Gray	30	P. O. Powers, Battelle Institute, on Plastics as Applied to Mining, Metallurgy and Coal.
Southwest Texas	Feb. 9	Corpus Christi	Raoul J. Bethancourt	277	M. M. Kinley, M. M. Kinley Co., talk and films on Oil Well Fires and Blowouts.
St. Louis	Dec. 10	York Hotel			S. S. Clarke, General Superintendent of Mines, Eagle-Picher Co., on Underground Mechanization in the Tri-State District.

Colorado School of Mines

A review of the last fifty years in the coal mining industry was presented by Thomas Allen, Colorado State coal mine inspector, at the Jan. 13 meeting of the Student Chapter at Colorado's School of Mines. Mr. Allen enlivened his speech on past and present mining methods, labor relations and government control with personal anecdotes drawn from his own experiences.

At the Feb. 10 meeting, President Herman Knight introduced Alfred Crofts, of Denver University's history department, who spoke of the young engineer's responsibility and future in a world of changing foreign and domestic social conditions. A question and answer period followed Dr. Knight's talk.—*Harvey W. Smith, Public Relations Chairman.*

University of Idaho

The Associated Miners of the University of Idaho were regaled at a banquet on Jan. 6. Eighty assembled members and guests were addressed, and saw movies shown by petroleum geologist John B. Miller, who heads the photogrammetric division of an American oil company in Colombia. His films portrayed native life, agriculture, industry, geology, and geography of the South American nation. —*A. G. Randall, Secretary-Treasurer.*

Missouri School of Mines

A record-breaking crowd of 243 men turned out for the Feb. 10 meeting to view two interesting movies and enjoy the usual refreshments. The first movie, "Lead Smelting at the St. Joseph Lead Co.," pictured all the steps in changing ore to lead, both in milling and smelting. The second, "The Army-Navy Football Game" was highly entertaining, and perhaps even educational. This Chapter is looking forward to breaking their new attendance record within a short time. —*Albert A. Jones, Secretary.*

South Dakota School of Mines

Not even a blizzard could stop Drill and Crucible Club members from gathering on Jan. 27 to hear Al Needham, of the Bureau of Mines, speak on reverse core drilling and present his own movies of the process. Also on the agenda for that night was the general superintendent of the Braden Mines in Chile, who gave a highly informative talk on block caving methods.

At the Club's Dec. 7 meeting, three movies were shown, all highly recommended to other Chapters. They were: The Story of Copper, Nickel Milling and Smelting, and one about the Homestake Gold Mine at Lead, S. D. The first two were provided by the Bureau of Mines Graphic Services Section in Pittsburgh. The above mentioned blizzard didn't even dent the Club's new attendance records, which have so far doubled last year's average of 35 at each meeting.—*Russell J. Gamberg, Secretary.*

News of AIME Members

John E. Bowenkamp

Charles S. T. Farish

Henry M. McLeod, Jr.

John E. Bowenkamp returned to Colombia in February after a combined vacation, leave of absence, and business trip to the United States and Canada. Now that he is back in Medellin he will continue to carry on in his capacity of mine examination engineer for Wellington Explorations Ltd., a subsidiary organization of the N. A. Timmins Corp. of Montreal. His airmail address is Apartado Aereo 817, Medellin.

William H. Bradbury graduated from the University of Colorado last August with a B.S. degree in chemical engineering and is now employed as an assayer for the Cia. Minera del Mexcala, Gro., Mexico.

John B. Breymann, III, after finishing his studies at MIT, is working for the Shenandoah-Dives Mining Co., Silverton, Colo.

Frank Cameron is working for the Saudi Arabian Mining Syndicate, Jeddah, Saudi Arabia. He had been living in Jenkintown, Pa.

J. A. Caverly, now with the Gardner-Denver Co., Quincy, Ill., used to work at the Snow Lake division of the Howe Sound Exploration Co., Snow Lake, Man.

A. J. Cayia has been elected president of the Inland Lime and Stone Co. He has been with the Company since 1928, and was formerly a mechanical engineer for the M. A. Hanna Co.

Charles S. T. Farish has been promoted to general superintendent of mines of the Cerro de Pasco Copper Corp. at La Oroya, Peru. He has been with Cerro since 1919 as mine engineer, general mine foreman, tunnel foreman, assistant superintendent, and superintendent.

L. M. Abell left Fiji, where he was with the Emperor Gold Mining Co., Vatukoula, last November, spent a few weeks in Canada and the States and then went on to Skouriotissa, Nicosia, Cyprus, where he is mill superintendent for the Cyprus Mines Corp.

Bert C. Austin, president of Bert C. Austin & Co., of San Francisco, is doing the consulting engineering work on the Vivian Mining Co.'s recently leased Pine Hill mine, in the Wolf district, southwest of Grass Valley, Calif.

Richard C. Badger, vice-president of Park City Cons. Mines Co., is directing the rehabilitation operations at the Company's Park City, Utah, property which had been shut down for five years.

Daniel F. Flowers is engineer for the Differential Steel Car Co., Findlay, Ohio, and gets his mail at 1109 S. Main St., Findlay.

Donald W. Frommer has established a permanent address at 16 Great Oaks, Rolla, Mo. Since last August he has been employed by the Rolla station of the Bureau of Mines, working on flotation and other types of mineral dressing.

Henry M. McLeod, Jr., who for the past three years was a project leader in T.V.A.'s process development division at Wilson Dam, Ala., has accepted a job with the research and development division of the Carbide and Chemicals Corp., at Oak Ridge, Tenn. His address is 110 Porter Rd., Oak Ridge.

Louis C. Ball has been appointed geologist of the Standard Gypsum Co. with headquarters in the Kaiser Bldg., Oakland, Calif. He worked for the Aluminum Co. of America before serving as a naval officer for two years during the war, seeing action during the Okinawa campaign and the subsequent minesweeping in Japanese waters. In 1946 he joined another Henry J. Kaiser operated company, the Permanente Metals Corp., and was engaged in the exploration of bauxite land under option in Surinam, Dutch Guiana.

Edward G. Fox, who has been president of the Shen-Penn Production Co., has become general manager of the Philadelphia and Reading Coal and Iron Co., Pottsville, Pa.

H. S. Fowler left his post as general superintendent of the Blubber Bay plant of the Pacific Lime Co. early in October to join the engineering staff of the Denver Equipment Co., Denver, Colo.

Percy Gardner, Jr., has the job of engineer with the Silver Dollar Mining Co. at Wallace, Idaho.

William D. Leonard, of 4416 View St., Oakland 11, Calif., is manager of the Emprise Sales Co.

David E. Morgan

David E. Morgan is traveling in European and African mining territories, representing various American mining equipment manufacturers and is also acting as a consulting engineer for foreign mining companies. He can be reached through his New York City office at 220 Broadway.

Ronald K. Sorem has taken the job of geologist with the U. S. Geological Survey in Washington, D. C.

Robert L. Swain is employed in Kimberly, Nev., as an underground engineer for the Consolidated Coppermines Corp. His mailing address is Box 206, Kimberly.

Glen C. Taylor has moved to Evans, Wash., where he is employed by the U. S. Gypsum Co. as a plant engineer.

Robert E. Thurmond is in Jerome, Ariz., where his mail is received at Box 1423, and his job is geophysical field engineer for the Newmont Mining Corp.

Frank E. Tippie can be reached in care of Cia. Minera y Refinadora Mexicana, Estacion Wadley, S. L. P., Mexico. He had been with Patino Mines and Enterprises Consolidated in Bolivia.

Theodore Toren, Jr., formerly with Day Mines, Inc., Wallace, Idaho, is employed by the Oliver Iron Mines in Hibbing, Minn. His new address is 1029 W. 29th St., Grand Rapids, Minn.

Abner A. Towers has been transferred from the New York office of the Dorr Co. to the Atlanta office. His new address is 2421 Sagamore Dr., Atlanta N. W., Ga.

N. de Voogd is general manager of Metalurgia Jofremars, Caixa Postal 38, São João del Rey, Minas Gerais, Brazil. Since October he has been in charge of operations at three properties of the Company, all situated in the São João del Rey tin belt, where he hopes to develop vein and placer mining and a small smelter.

H. A. Waite left Salt Lake City the end of December to go to Honduras as general superintendent of the New Idria Honduras Mining Co., Santa Rosa de Copan, Honduras.

Arnold H. Walker, formerly with Sladen Malartic Mines Ltd., is now working for Barnat Mines Ltd., Box 33, Malartic, Que.

Joseph J. Wallace, formerly a student-trainee with the Pittsburgh Coal Co., has joined the staff of the Bureau of Mines at Pittsburgh as a mining engineer.

Robert H. Wheless, who had been a student at the University of Alabama, is working at the Praco mine of the Alabama By-Prod Corp., Praco, Ala.

Harold H. White

Harold H. White severed a twenty-year connection with the Atlas Powder Co. on Feb. 1, to take charge of a newly formed consulting engineering company composed of Texas engineers and scientists. Chief company operations will be the control of blasting in settled areas, and measurement of blast vibrations. Mr. White was instrumental in the formation of Atlas's subsidiary company in Mexico, and directed its operations until 1947. His new firm's headquarters will be in Houston, with branches in New York, Chicago, and Cleveland, rounding out the nation-wide scope of operations.

T. A. Woods-Smith has moved from Los Angeles, and is now associated with Patiño Mines and Enterprises Consolidated, Siglo XX, Llallagua, Bolivia.

Dan S. Young, former chief engineer and geologist for the Castile Mining Co., has gone to Montreal, Wis., where he is associated with Oglebay Norton and Co.

• In Petroleum Circles

Forrest J. Allen, Jr., graduated from the University of Oklahoma in January and has gone to work for the California Co., 1818 Canal Bldg., New Orleans 12, La.

Donald L. Bohannan has moved to Wyoming with the Stanolind Oil and Gas Co. His address is P. O. Box 966, Midwest, Wyo.

Ira H. Cram has changed his address for mail from the Pure Oil Co. of Chicago to the Continental Oil Co., Ponca City, Okla., being a vice-president of the latter company.

Jack D. Duren is working for the Shell Oil Co. as a junior exploitation engineer. Mail reaches him at 521 E. First St., Trinidad, Colo.

Patrick N. Glover, exploitation engineer for the Shell Oil Co. at Los Angeles, lives at 829 S. Bundy Dr., Los Angeles 24, Calif.

Wilber H. Griffin, who was with Baker Oil Tools, is general sales manager for CAMCO, Inc., manufacturers and distributors of Camco gas lift equipment, in Houston. His permanent address is 1601 S. Shepherd Drive, River Oaks Gardens, Houston 19.

David P. Hoover has been working on a trainee program sponsored by the Gulf Oil Corp. with an address at 506 LaFayette, Pittsburg, Texas.

Alden J. Laborde, whose last address was in New Orleans, is now marine superintendent with Kerr-McGee Oil Industries, Morgan City, La.

Billy B. Lane is working as a field engineer for the Sohio Petroleum Co. at Eureka, Kans.

Philip Maverick, Jr., is a petroleum reservoir engineer with the Phillips Petroleum Co., 219 S. Big Spring St., Midland, Texas.

Neal McCaskill has returned from Venezuela, where he was working as a petroleum engineer with the Venezuela Atlantic Refining Co., and can now be reached at 1708 16th Street, Lubbock, Texas.

Paul M. McMinn, formerly at the University of Wisconsin, has moved to Denver, Colo., to work for the California Co.

Roderick G. Murchison resigned from the Socony-Vacuum Oil Co. of Colombia in March 1948 and since that time has been instructor in geology at the University of North Carolina, Chapel

Hill. His permanent address remains P. O. Box 547, Rocky Mount, N. C.

F. Ward O'Malley has joined the exploration department of the Continental Oil Co. and is working at the Denver office, Rm. 1029, Continental Oil Bldg.

E. R. Osburn is reached now in care of the Union Producing Co., P. O. Box 1422, Monroe, La.

Harold E. Parsons transferred on Jan. 20 from Lima, Peru, where he has been for almost four years, back to Bogota, Colombia, still with the same employers, Socony-Vaccum Oil Co. His work in Bogota will be much the same as he was doing in Peru, where he was working on photo-geological mapping, with several extended field trips in the montaña—the jungle lowlands east of the Andes in the region of the upper Amazon drainage. He expects to return to the States on leave some time this summer. His address is Apartado Nacional 1140, Bogota, Colombia.

L. F. Peterson has terminated several years service with the Stanolind Oil and Gas Co., to join as a partner in the Midland, Texas, consulting firm of Henderson, McMillian and Peterson. The firm will handle petroleum geological and engineering problems, property management, leasing, title examination, and well completions.

Darrell S. Pierson, no longer a student at the University of Utah, is employed by The Texas Co. producing department at Sunburst, Mont., as a petroleum engineer-trainee.

Floyd W. Preston is now a research engineer with the California Research Corp., a Standard Oil Co. of California subsidiary, at La Habra, Calif. He joined the Company recently, after receiving his M.S.E. degree from the University of Michigan.

Claude O. Stephens is now in Worland, Wyo., working for the Texas Gulf Sulphur Co. His address there is P. O. Box 15.

Arthur G. Sullivan, Jr., no longer a student at Texas A&M, is a junior petroleum engineer with the Ohio Oil Co., with a new address at 121½ Old Kilgore Highway, Henderson, Texas.

Robert P. Thomas is now employed as a junior seismologist in training with the Shell Oil Co. He expected to receive his M. A. degree from the University of California in February.

William H. Wadlington, having finished his studies at Texas A&M, is a junior petroleum engineer with the Stanolind Oil and Gas Co., Box 1518, Levelland, Texas.

Arthur L. Jenke

Arthur L. Jenke is now in Abilene, Texas, where he is associated with Riley Maxwell, consulting geologist. Mr. Jenke's chief interest is in the operation of a core testing laboratory which he set up several months ago in the West Texas city. Prior to his venture into the consulting field, he attended Washington University in St. Louis, receiving a M. S. degree in geology last June. During the academic year 1947-1948 he held a Shell Oil Co. fellowship in geology. A tenure of approximately seven years with the U. S. Geological Survey was brought to a close with his resignation last May.

Karl L. Wehmeyer, Jr., has been appointed resident geologist of the Mene Grande Oil Company's Bolivar coastal fields. His address is Geological Dept., Apartado 234, Maracaibo, Venezuela.

Norman Wilson is district geologist for the Great Lakes Carbon Corp., 417 Indiana Bank Bldg., Evansville, Ind.

• In the Metals Divisions

Donald H. Beilstein has the job of junior metallurgist in the Federated Metals division of the AS&R Co. in San Francisco. His home address is 272 Everett Ave., Palo Alto, Calif.

William W. Berkey is working for the Kaiser-Frazer Corp. at Willow Run, Mich., as a metallurgist.

Jay R. Burns is now employed as a research engineer in the process development department, magnesium division of the Dow Chemical Co. He had been chief of the magnesium unit, materials laboratory, Wright-Patterson Air Force Base.

John M. Crockett is assistant metallurgical engineer with the Air Reduction Sales Co., New York City. His mail goes to 23 Bounty St., Metuchen, N. J.

Edmund C. Franz is in Cleveland, Ohio, now, working for the Aluminum Co. of America, 2210 Harvard Ave.

Emerson L. George is a junior engineer for McConway Torley Inc. of Pittsburgh. His home address is 219 Oakland Ave., Apt. 31, Pittsburgh 13.

Russell G. Hardy has moved from Baltimore, Md., where he was with the Gibson & Kirk Co., to Chicago to work for the Argonne National Laboratories. His address is 1550 E. 61 St., Chicago.

Frederick A. Hartgen is sales manager and metallurgist for Nutmeg Crucible Steel, Branford, Conn.

Alexander L. Feild

Alexander L. Feild, associate director of research for the Armco Steel Corp., was awarded an honorary degree of Doctor of Science on Feb. 5 by the Stevens Institute of Technology, Hoboken, N. J. A Tarheel by birth and education, with degrees from the University of North Carolina and from N. C. State College, he has worked for his state agricultural department and for the U. S. Bureau of Mines. For the last thirty years he has been a research man in industry, during which time 28 U. S. patents have been awarded to him.

David W. Pettigrew, Jr., who graduated from the Carnegie Institute of Technology last June with a B.S. degree in metallurgy, has returned to the Aluminum research laboratories of the Aluminum Co. of America, New Kensington, Pa., where he is employed as a research engineer in metallography.

Morris Steinberg, of the metallurgical division of Horizons Incorporated, has ben appointed head of the division. Dr. Steinberg received his doctorate from MIT in June, 1948, and joined the staff of Horizons at that time. He is co-author of "Lead-grid Study of Metal Powder Compaction" presented at the Annual Meeting in San Francisco in February.

Robert C. Stanley

John F. Thompson

Paul D. Merica

Robert C. Stanley, president since 1922, director since 1917, and chairman and president since 1937 of the International Nickel Co. of Canada, continues as chairman of the board, while **John F. Thompson,** who has been an executive vice-president since 1936 and a director and member of the executive committee since 1931, has become president. **Paul D. Merica,** vice-president since 1936 and a director, is now executive vice-president. Under Mr. Stanley's chairmanship, International Nickel has become the world's largest producer of nickel and platinum metals and the largest copper producer in the British Empire. Recently he resigned as chairman of the trustees of Stevens Institute of Technology, after serving for twelve years. Dr. Thompson joined the Company as a metallurgist in 1906, becoming manager of operations in 1921 and assistant to the president seven years later. He supervised the construction and initial operations of the Company's Huntington, W. Va., works, founded for the production of nonferrous alloys. For many years the Company's production in the States and its operations and markets in Great Britain and Europe have been among the matters in his particular charge. Dr. Merica has been with International Nickel since 1919, becoming director of research and later associate manager of the development and research department. In addition to his responsibilities as vice-president, he has continued to give special attention to the Company's research activities in Canada, the United Kingdom, and the States. He has evolved numerous iron-nickel and copper-nickel alloys and is the author of many technical papers and articles.

Donald D. Helman is working for the Ohio Steel Foundry Co., Springfield, Ohio, as a metallurgist.

Harry Hey has been made managing director of the Electrolytic Zinc Co. of Australasia, Melbourne, Australia.

Norton Jackson has left the Emperor Gold Mining Co., Vatukoula, Fiji Islands, to become metallurgical engineer for the Department of Mines, South Australia. His new address is 64 Tusmore Ave., Tusmore, S. Australia.

S. T. Jazwinski, vice-president of the Detroit Steel Casting Co., Detroit 10, Mich., has gone to Rio de Janeiro for several months.

Bruce S. Old

Bruce S. Old has been elected to the board of directors of Arthur D. Little, Inc., research and engineering organization. Dr. Old joined the concern in 1946 after leaving the Navy, where he served in the Office of Research and Invention with the rank of Commander. He is now in charge of process metallurgy for Arthur D. Little as well as consultant to the Office of Naval Research and the Atomic Energy Commission, in the latter as chief of metallurgy and materials branch, Division of Research.

Peter J. Kassak, Jr., former University of Pennsylvania student, is now a cadet engineer with the Public Service Electric and Gas Co. of Newark, N. J. His address is 729 Colonial Ave., Union, N. J.

John R. Kunkel has left the Fansteel Metallurgical Corp. to work at the Ingersoll steel and disc division of the Borg-Warner Corp., Chicago. His mail is sent to 12409 S. Ada St., Chicago 43.

LeRoy H. Markway is working for the Shell Oil Co. at Wood River, Ill., as a junior engineer.

Raymond L. McGaughey graduated from the University of Illinois last summer with a degree of B. S. in metallurgical engineering. At present he is employed by the Elgin National Watch Co. as a research metallurgist. His mail goes to 1191 Logan, Elgin, Ill.

Whitney P. Mee has been retained as consulting metallurgist by Cia. Metalurgica Peñoles, a subsidiary of the American Metals Co. since August 1947. Most of his time has been spent at the Peñoles lead-copper smelter at Torreon, Coah., with periodic trips to the company's headquarters at Monterrey, N. L. Upon completion of an extensive construction program late this year, the capacity of this plant will have been practically doubled, and many improvements are being made which will make the Torreon smelter one of the most modern and efficient in Mexico. **Philip Doerr** is manager of the plant and **I. M. Symonds** is in charge of operations.

Wilbur L. Mudge, Jr., has taken the job of metallurgist with the Foote Mineral Co. of Philadelphia, and is continuing his graduate studies at the University of Pennsylvania. His address is 2840 Washington Ave., Apt. C, Camden, N. J.

Edward C. Nelson, former assistant metallurgist at the Naval Research Laboratory, Anacostia Station, Washington, D C., has joined the staff of Rensselaer Polytechnic Institute, Troy, N. Y., as an instructor in metallurgical engineering.

Robert M. Parke, who has been at the applied physics laboratory of Johns Hopkins University, is acting as technical adviser for Battelle Memorial Institute, Columbus, Ohio.

T. W. Plante, superintendent of blast furnaces for the Jones & Laughlin Steel Corporation's Eliza works in Pittsburgh, will go to Chile in the spring to be superintendent in charge of blast furnaces and raw materials for the Pacific Steel Co. of Chile. He will be in Pacific Steel's New York offices for a while and then make his home in Concepcion, where the Company is now building an integrated steel mill.

Kenneth L. Quigley is associated with Northern Ordnance Inc., Columbia Heights Station, Minneapolis, Minn. He was with the Champion Motors Co.

Edward J. Ramaley has accepted the post of tool design research engineer with the Lockheed Aircraft Corp., Burbank, Calif.

Fred Romano, former research metallurgist for the National Smelting Co., has taken over as superintendent of plant metallurgy for the Monarch Aluminum Mfg. Co., Cleveland, Ohio.

Carl H. Samans recently resigned as chief, metallurgy section, research laboratory, American Optical Co., Southbridge, Mass., and can be reached at the Engineering Research Dept., Standard Oil Co. (Indiana), 910 S. Michigan Ave., Chicago 80.

Eraldus Scala, who became a Student Associate in 1947 while attending Columbia University, is now employed in the research laboratory of Chase Brass & Copper in Waterbury, Conn. His new address is 31 Chipman St., Waterbury.

J. R. Scrivener, sales engineer with the Permanente Products Co., has transferred from the Chicago office to the Company office at 1924 Broadway, Oakland 12, Calif.

Tryggve Smedsland, native of Norway who attended the Missouri School of Mines, and joined the Institute last year as a Student Associate, is now back in his homeland, teaching at the Norwegian Institute of Technology in Trondheim. Members who would like to correspond with their Norwegian co-worker can reach him at the Department of Metallurgy, Norges Tekniske Högskole, Trondheim.

N. S. Spence recently was appointed director of research and development for Dominion Magnesium Ltd., Haley, Ont.

Frank T. Sisco

Frank T. Sisco, director of Alloys of Iron Research, was appointed technical director of the Engineering Foundation, effective March 1. The Foundation, joint research agency of the AIEE, AIME, ASCE, and ASME, sponsors and supports fundamental research in all fields of engineering. Mr. Sisco has worked in the operating departments of various steel companies and as chief of the metallurgical laboratory of the U. S. Army Air Corps at Wright Field, Dayton, Ohio. He has been in charge of Alloys of Iron Research since 1930 and for the present will continue this project.

David T. Steele has taken a job with the American Metal Co., 1 N. La Salle St., Chicago 2. He was with the Duquesne Smelting Corp., Pittsburgh.

P. L. Steffensen, former superintendent of the concentrator plant of the Bethlehem Steel Co., is manager of the Company's raw materials research, Lebanon, Pa.

R. J. Turney has been transferred from the Tacoma plant to the Selby plant of the American Smelting and Refining Co., 405 Montgomery St., San Francisco.

Joseph J. Warga, who was with the Owens-Illinois Glass Co., is now working for the Sperry Gyroscope Co., Great Neck, L. I., N. Y., on process and materials standards.

Harold K. Work became director of the research division of the College of Engineering of New York University on Feb. 1. He was manager of the research and development division of the Jones & Laughlin Steel Corp. Dr. Work is Vice-Chairman of the Institute's Iron and Steel Division.

Obituaries

James S. Douglas

AN APPRECIATION BY R. D. LEISK

James S. Douglas, "miner and banker," as he chose to be listed in the directory of the AIME, died at the age of eighty at his home in Montreal on Jan. 2. His passing marked the end of a notable career that left an indelible imprint upon the history of copper mining in the southwest.

He was born in Quebec in 1868. His illustrious father, James Douglas, was at the time engaged in the development of a chemical process for the treatment of copper ores, an activity which in 1875 necessitated moving from Quebec to Phoenixville, Pa., where James S. Douglas spent much of his boyhood. Dr. Douglas soon began to devote more and more of his time to the investigation of mining properties in the west and southwest and this resulted in an association with the late W. E. Dodge and D. Willis James that brought the old metal trading firm of Phelps Dodge and Co. into the copper mining business at Bisbee and culminated in the formation of the present Phelps Dodge Corp. of which Dr. Douglas was the first president.

With this background, James S. Douglas as a young man developed a keen interest in the growing mining industry of the southwest together with its requirements of rail transportation and finance. He investigated and operated a number of the early mining properties in Arizona and northern Mexico and later engaged in banking and other business. He was perhaps best known for his part in the discovery of the copper bonanza of the United Verde Extension in 1915 at Jerome, Ariz. Here with the help of an associate, the late George E. Tener, he took the lead in reorganizing and backing a venture started by L. E. Whicher. The UVX, as it was called, was a long-shot geological gamble of no small proportions, involving the exploration of faulted Pre-Cambrian formations covered by some 800 ft. of sedimentaries and lavas. Under the direction of Jimmy

Necrology

Date Elected	*Name*	*Date of Death*
1940	Elwood Bachman	Dec. 16, 1948
1936	Arthur J. Boase	Unknown
1920	Charles E. Bruff	Feb. 25, 1949
1942	Mark G. Carhart	March 6, 1949
1918	Howard Drullard	Jan. 29, 1949
1916	Horace S. Gulick	Jan. 31, 1949
1938	Philip H. Holdsworth	Nov. 21, 1948
1932	Donald R. Knowlton	March 9, 1949
1935	Otto G. Leichliter	Sept. 8, 1949
1930	R. John Lemmon	Jan. 26, 1949
1916	Walter B. Miller	Sept., 1948
1936	Arthur S. Nichols	Feb. 18, 1949
1913	Walter V. Rohlffs	Unknown
1940	William A. Rose	Jan. 30, 1949
1945	James W. Starks	Feb. 3, 1949
1904	David Rhys Thomas	March 4, 1949
1892	Bailey Willis	Feb. 19, 1949
1916	Harold E. Willson	Unknown

Douglas, a new shaft was sunk and after many disappointments and the expenditure of much money the venture became a sudden and astounding success when a crosscut on the 1400 level penetrated what was probably the greatest body of high-grade chalcocite ore ever discovered. For three solid years thereafter the ore produced by this great mine averaged 23 percent copper and by the time the ores were exhausted in 1937 the shareholders had received over $50,000,000 in distributions. James S. Douglas served as president of the United Verde Extension Mining Co. until it was dissolved in 1939.

During the first World War he spent much of his time and personal funds in Red Cross work in France where he came to know and admire the wartime Prime Minister, Georges Clemenceau, after whom the UVX smelter town was later named. He wore the ribbon of a Chevalier of the Legion of Honor and for many years it was his custom to spend a month or two each year in France among the simple surroundings he loved so well.

Jimmy Douglas was by nature an aggressive individualist of the old school that contributed so much to the building of the West. He believed in simple and wholesome living and abhorred waste and extravagance. A shrewd trader, uncompromisingly honest in his dealings, he did business on the theory that a man's word should be as good as his bond and that a written contract was no better than the integrity of the signer. He was a man of high character and ideals, and while his approach to the solution of economic and business problems was characteristically simple and direct, he would not compromise principle for the sake of an easy solution. He appreciated art and good music and loved animals, especially the horses which had carried him over so many miles of mountain and desert in his younger days, and the little Arizona quail which came to look for crumbs at the doorstep of his house at Jerome. Well read, a deep thinker and good conversationalist, his opinions were his own and vigorously expounded, but he was nevertheless fair minded and respected the opinions of others so that an argument with him was a stimulating experience that always ended with increased mutual respect. He was a staunch and loyal friend as many who knew him came to realize in time of adversity. As a host he was charming, a courtly gentleman, and ever a good companion.

The memories of many pleasant visits with him at Jerome and at Douglas, Ariz., at the old family home at Spuyten Duyvil on the Hudson, and at Montreal and St. Pierre les Becquets, all carry with them the deep appreciation of having known James S. Douglas.

Proposed for Membership

Total AIME membership on February 28, 1949, was 15,326; in addition 3884 Student Associates were enrolled.

ADMISSIONS COMMITTEE

James L. Head, Chairman; Albert J. Phillips, Vice-Chairman; George B. Cortess, T. B. Counselman, Ivan A. Given, George C. Heikes, Richard D. Mollison, and Philip D. Wilson.

Institute members are urged to review this list as soon as the issue is received and immediately to wire the Secretary's office, night message collect, if objection is offered to the admission of any applicant. Details of the objection should follow by air mail. The Institute desires to extend its privileges to every person to whom it can be of service but does not desire to admit persons unless they are qualified.

In the following list C/S means change of status: R, reinstatement; M, Member; J, Junior Member; AM, Associate Member; S, Student Associate; F, Junior Foreign Affiliate.

ARIZONA

Ajo—LEWIS, EVAN GERRIT. (R—M). Mill superintendent, New Cornelia branch, Phelps Dodge Corp.

Benson—TOWLE, LOUIS WALLACE. (M). Technical service supervisor, Apache Powder Co.

Superior—NOBS, KENNETH ASTREDO. (C/S—J-M). Level boss, Magma Co.

CALIFORNIA

Alhambra—FATT, IRVING. (J). Associate research chemist, California Research Corp. MUEHL, WALLACE WILLIAM. (M). Sales engineer, Link Belt Co.

Balboa—PYLES, ERNEST E. (AM). Assistant to executive vice-president and general manager, Jergins Oil Co.

Berkeley—GORDON, GEORGE MALVEN. (C/S—J-M). Spectrographer, University of California.

Concord — RHODES, LOUIS CLIFFORD. (R,C/S—JA-M). District manager, San Francisco office, Joy Mfg. Co.

Long Beach—GORE, DAVID BELL. (M). Sales engineer, Eastman Oil Well Survey Co.

Piedmont—YOPES, PAUL FREDERICK. (C/S—J-M).

San Francisco — REEDER, DAVID BRIERLY. (M). Division manager, Electro Metallurgical Sales Corp. WITT, FRANK. (M). Consulting mining engineer; general manager, Western States Mining Co.

Santa Maria — EVANS, KENNETH RUSSELL. (M). Vice-president, Bell-Casmite Oil Co., and A. E. Bell Corp.

Taft—GRIVETTI, REX MICHAEL. (C/S—J-M). Geologist, The Texas Co.

COLORADO

Climax—COOLEY, CHARLES MILTON. (R,C/S—S-J). Engineer, planning dept., Climax Molybdenum Co.

Denver—HARRIS, JAMES DAWSON, JR. (R,C/S—J-M). District engineer, Rocky Mountain district, Core Laboratories, Inc. STEDMAN, ALAN LEROY. (C/S—S-AM). Construction engineer, Armco Drainage & Metal Products, Inc. WATSON, GEORGE CHARLES. (M). Owner, Domestic Coal Co.

Leadville—GREENLEE, BARNETTE BATES. (R,C/S—J-M). Mine foreman, Resurrection Mining Co.

CONNECTICUT

Ansonia — TOUSSANT, WILLIAM THEOPHILE. (M). Sales metallurgist, Bridgeport Brass Co.

Hartford — DORVEL, ARNOLD ALEXANDER. (J). Metallurgist, Hartford Electric Steel Co.

Riverside—BEAN, JAMES JOSEPH. (M). Mineral dressing engineer, American Cyanamid Co.

Stamford — ANDERSON, ELWOOD ROBERT. (AM). Special assistant to vice-president, manufacturing department, Ethyl Corp.

Torrington — BAKER, ROBERT STUCKEY. (C/S—J-M). Works manager, Torrington branch, American Brass Co.

Westport—WEBER, WILLIAM C. (R,C/S—A-M). Process engineer and director of technical data, The Dorr Co.

FLORIDA

Brewster — CHESSON, MAYWOOD W., JR. (J). Assistant flotation plant superintendent, American Cyanamid Co.

IDAHO

Wallace — RICHARDS, BENJAMIN STEPHENS, JR. (AM). Sales representative, explosives, E. I. du Pont de Nemours & Co.

ILLINOIS

Chicago — DALLMAN, ROBERT ADOLPH. (M). Metallurgist, Robert W. Hunt Co. HANSEN, MAX. (R—M). Associate professor, department of metallurgical engineering, Illinois Institute of Technology. WELLS, RALPH G. (AM). Metallurgist, Carnegie-Illinois Steel Corp.

Hillsboro — RULE, WILLIAM THOMAS. (J). Plant metallurgist, Eagle-Picher Co.

Oak Park — MAXSON, MARSHALL WHITNEY. (M). Chief process metallurgist, Carnegie-Illinois Steel Corp.

KANSAS

Lawrence—HAMBLETON, WILLIAM WELDON. (J). Instructor of petrography, University of Kansas.

Wichita — HADDOX, R. PUTNAM. (J). Junior exploitation engineer, Shell Oil Co. HELLAR, DONALD LOUIS. (M). Geologist, Sohio Petroleum Co. PARRIOTT, ROBERT BENEDUM. (R,C/S—J-M). Geological engineer, Stickle Drilling Co. TATLOCK, THOMAS ALBERT. (M). Production superintendent, J. H. Tatlock. ZOLLER, HENRY E. (M). President, Derby Oil Co.

LOUISIANA

Jennings — BROCK, DONALD MARSH. (M). District manager, Garrett Oil Tools, Inc.

New Orleans—RATLIFF, J. PAUL, JR. (C/S—J-M). Partner and manager, Rey Supply Co.

MASSACHUSETTS

Swampscott — MOORE, JAMES HENRY. (M). Director, metals research department, National Research Corp.

MICHIGAN

Ann Arbor—FREY, DONALD NELSON. (J). Research associate, department of engrg. research, University of Michigan.

Detroit—WIEDMAN, CARL S. (C/S—S-J). Research metallurgical engineer, Carboloy Co.

Ishpeming — ALLEN, ERNEST A. (AM). Geological technician, The Cleveland-Cliffs Iron Co.

MINNESOTA

Calumet—BOLITHO, WAYNE RUSSELL. (C/S—S-J). Assistant chief engineer, Inter-State Iron Co.

Coleraine—VANDELINDER, MARION DELBERT. (C/S—S-J). Mining engineer-trainee, Oliver Iron Mining Co.

Minneapolis — WARREN, ALICE ROCKWELL. (AM). Vice-president and secretary, Langdon-Warren Mines, Inc.

St. Paul—BATHKE, ALFRED SNYDER. (M). Partner, F. H. Bathke.

MISSISSIPPI

Laurel—BAKER, WILLIAM HENRY. (J). Drilling fluid engineer, Magnet Cove Barium Corp. CROWE, JESSE OVEL. (M). Assistant zone superintendent of production, production division, Gulf Refining Co. McGLOTHLIN, JOHN THOMAS. (M). Consulting geologist.

MISSOURI

Bonne Terre—JAMES ALLAN HARRIS. (C/S—J-M). Field geologist, St. Joseph Lead Co.

Columbia — FRAUNFELTER, GEORGE HENRY. (C/S—S-J). Graduate assistant in geology, University of Missouri.

Florissant—DESLODGE, BERNARD FARRAR. (AM). Geologist, Minerva Oil Co. DESLODGE, JOSEPH. (M). President, Minerva Oil Co.

Fredericktown—RIGGS, LAWRASON, III. (R,C/S—S-M). Business representative, Mine La Motte Corp.

Kansas City—NORQUIST, DONALD E. (M). Metallurgical sales, Sheffield Steel Corp.

NEW MEXICO

Carlsbad—JUHOLA, NEIL MATTHEW. (M). Acting mine foreman, Potash Co. of America.

Hobbs—LAMONT, NORMAN. (C/S—S-J). Trainee, Shell Oil Co.

Silver City—GRUNIG, JAMES KITCHELL. (J). Geologist, U. S. Geological Survey.

NEW YORK

Brooklyn—CUTLER, SEYMOUR S. (J). Plant manager, Standard Type Metals Corp.

Jamaica — GOODMAN, HERBERT HAROLD. (C/S—S-J). Metallographer, American Electro Metal Corp.

New York—FRIEDMAN, LOUIS T. (M). Head, department of metallurgical engineering, Sam Tour & Co.

Schenectady — BALDWIN, ELMER EDMUND. (C/S—S-J). Engineer, on rotating assignment, General Electric Co.

White Plains—LORCK, KARL. (M). Head, technical division, U.S.A. branch, Elektrokemisk A. S.

OHIO

Cleveland — KRONBACH, GEORGE EDWIN. (M). Senior metallurgist, Thompson Products, Inc.

Columbus—SMITH, WILLIAM HENKING. (J). Assistant geologist, Geological Survey of Ohio.

Middletown—ELLIS, CEDRIC DOUGLAS. (M). Assistant superintendent, Open Hearth, ISCOR.

Olmsted Falls—IVES, LEE EMMET. (R—M). President, Lee E. Ives, Inc.

Warren—WILLIAMS, JOSEPH OSCAR. (J). Open hearth metallurgist, Republic Steel Corp.

OKLAHOMA

Henryetta — TAYLOR, GENE KINNEY. (M). Vice-president in charge of operation, Ben Hur Coal Co.

Miami — NEAL, CHARLES AIMAN, JR. (AM). Vice-president, Bells Wells Oil Co.

Moore—WILLIAMS, JAMES JUNIOR. (J). Junior engineer, petroleum production, Cities Service Oil Co. (Del.).

Norman—MADDOX, GAISER DAWSON. (R,C/S—J-M). Assistant professor, petroleum engineering, University of Oklahoma.

Oklahoma City — COOKE, JOHN THIEME. (R,C/S—J-M). Petroleum engineer, Sohio Petroleum Co. SCHEIRMAN, GENE LEWIS. (C/S—S-J). Junior exploitation engineer, Shell Oil Co. SVOBODA, FLOYD JOSEPH. (J). Rotary service, The National Supply Co.

Tulsa—AMSTUTZ, RAY W. (C/S—S-J). Junior petroleum engineer, Eariougher Engineering. DERRICK, A. M., JR. (R,C/S—S-J). Junior petroleum engineer, Stanolind Oil & Gas Co. MAUL, ROBERT VINCENT. (M). Chemical engineer, Stanolind Oil & Gas Co.

PENNSYLVANIA

Bethlehem — WAHL, WILLIAM GEORGE. (M). Geologist, Bethlehem Steel Co.

Bristol — SUTER, WILLIAM GUY. (C/S — S-J). College representative, John Wiley & Sons.

Clairton — SMITH, FRED R. (M). Superintendent, open hearth, Carnegie-Illinois Steel Corp.

Groveton — MARSALKA, JOSEPH JEROME. (C/S—J-M). Research laboratory supervisor, Blaw Knox Co.

Hazleton — REESE, ANTHONY GEORGE. (M). Mining engineer, anthracite flood prevention project, Bureau of Mines.

McKeesport — EKHOLM, LAVERNE G. (C/S—J-M). Assistant chief metallurgist, Duquesne works, Carnegie-Illinois Steel Corp.

Philadelphia — DANDO, ELON E. (AM). Divisional sales manager, Aero Service Corp. LANSDALE, PHILIP THOMAS. (M). Metallurgist, Henry Disston & Sons.

Pittsburgh — DRIESSEN, MAXIMILIAAN GUSTAAF. (M). Consulting engineer, Heyl & Patterson, Inc.; Koppers Co. HAMMOND, JOHN A. (AM). Pittsburgh division manager, National Carbon Co. LOUGHREY, DANIEL RIPLEY. (M). Superintendent, open hearth & Bessemer, Jones & Laughlin Steel Corp.

Pottsville — WHAITE, RALPH HAROLD. (M). Mining engineer, Bureau of Mines.

SOUTH CAROLINA

Charleston — KEILEN, JOHN J., Jr. (C/S—S-M). Project leader, West Virginia Pulp and Paper Co.

SOUTH DAKOTA

Lead — RICE, ARTHUR JAMES. (C/S—J-M). Cost engineer, Homestake Mining Co.

TEXAS

Alice—COOK EDGAR LOYD. (J). District engineer, Arkansas Fuel Co.

Anna—WEST, GEORGE WILLIAM. (M). Petroleum engineer, Sinclair Prairie Oil Co.

Austin—BARNES, BYRON ARTHUR. (R,C/S — J-M). Petroleum engineer, Magnolia Petroleum Co.

Corpus Christi — MOORE, ALVAN AUGUSTUS. (M). Partner, Clark & Bus Moore Oil Well Servicing Co.

Dallas — OWENS, DENNIS EMORY. (AM). Superintendent, bottom hole sample laboratory, Core Laboratories, Inc.

Delmita — BIRDWELL, WARRIE RUSSELL, JR. (J). Field engineer, Sun Oil Co.

El Paso — WASHBURN, ALWYN LOUIS. (AM). Co-owner, sales manager, Don A. Carpenter Co.

Ft. Worth—GROGINSKI, PHILIP S. (M). Engineer and geologist.

Hebbronville — McAFEE, ROBERT VANDERVEER. (R,C/S—S-J). Area engineer, Sun Oil Co.

Houston — DODD, JAMES GRADY. (M). Reserve geologist, Tennessee Gas Transmission Co. FORD, ROBERT DAVIS. (M). Public relations manager, Schlumberger Well Surveying Corp. KINLEY, JOHN CARY. (M). Engineer, M. M. Kinley Co. MORIAN, STANLEY COFFIN. (R,C/S — J-M). President and manager, Dixie Chemical Co. PALMER, ARTHUR BOWEN. (M). General manager, Sperry-Sun Well Surveying Co. PLAZA, JOSEPH BREWER. (AM). Reservoir engineer, division office, Stanolind Oil and Gas Co. TENNANT, JOSEPH ALLAN, JR. (M). Economist, Cameron Iron Works.

Lone Star—BOND, WILLIAM ROBERT. (M). Works manager, Lone Star Steel Co.

Midland — BLACKWOOD, JAMES COSBY. (M). Petroleum engineer, Amerada Petroleum Corp. HENDERSON, GEORGE HARVEY. (M). Electric well services supervision, Halliburton Oil Well Cementing Co.

Odem—BRADY, HAROLD JUDSON. (C/S—S-J). Petroleum engineer, Seaboard Oil Co.

Tyler—VOGENTHALER, THOMAS J. (C/S—S-J). Junior engineer, Schlumberger Well Surveying Corp.

UTAH

Salt Lake City—URQUHART, ROBERT DEAN. (M). Mining engineer, Utah Fuel Co.

Tooele — DAWSON, HARMEL ARTHUR. (C/S—S-J). Metallurgist, Combined Metals Reduction Co.

WASHINGTON

Spokane—LINDEMUTH, JACOB H. (M). General superintendent, Mead Works, Permanente Metals Corp.

WISCONSIN

Milwaukee — FOLEY, EDWARD JAMES. (M). Research metallurgist, Ladish Co.

WYOMING

Casper—FANSHAWE, JOHN RICHARDSON, 2nd. (M). Acting district manager, Rocky Mountains, Seaboard Oil Co. of Delaware.

ALASKA

Fairbanks—HELLERICH, GEORGE. (R,C/S — AM-M). Manager, Alaska dredge operations, Brinker-Johnson Co. LOFTUS, THEODORE ALBERT. (M). Superintendent, U. S. Smelting Refining & Mining Co.

BRITISH COLUMBIA

Salmo — STARCK, LOUIS PHILIP. (C/S—S-J). Assistant mill superintendent, Emerald tungsten project, Canadian Exploration, Ltd.

MANITOBA

Bissett—O'HARA, THOMAS ALAN. (C/S—S-J). Surveyor, San Antonio Gold Mines, Ltd.

Winnipeg—ALLAN, JOHN DONALD. (C/S—S-M). Chief geologist, Manitoba mines branch, Department of Mines and Natural Resources.

ONTARIO

Kingston — HONE, ANDRE. (M). Head, physical metallurgy division, Aluminum Laboratories, Ltd.

SONORA

Moreno—SPLANE, JOHN L. (C/S—S-M). General superintendent, Cia. Minera de San Jose.

BOLIVIA

Huanuni — VAN RAADSHOOVEN, WILLEM HENDRIK. (J). Mining engineer, Empresa Minera "San Jose".

BRAZIL

Volta Redonda, Est. do Rio—BASTOS, EURICO ALVES FERREIRA. (J). Assistant engineer, open hearth department, Cia. Siderurgica Nacional.

CHILE

Concepcion—PAIDASSI, JEAN. (M). Professor of metallurgy, University of Chile.

VENEZUELA

Caracas — PIERCE, A. CHARLES. (C/S—S-J). Geologist II, Creole Petroleum Corp.

ENGLAND

London — TYLECOTE, RONALD FRANK. (C/S—JFA-M). Investigator, British Non-Ferrous Metals Research Association.

ICELAND

Reykjavik—TRYGGVASON, TÓMAS. (AM). Consulting geologist, University Research Institute.

SPAIN

Madrid — SOTO, AMADOR GONZALEZ. (C/S—AM-M). Laboratory chief, Iron & Steel Institute of Spain; chief professor of Metallurgy, Escuela Politecnica del Ejército.

SWEDEN

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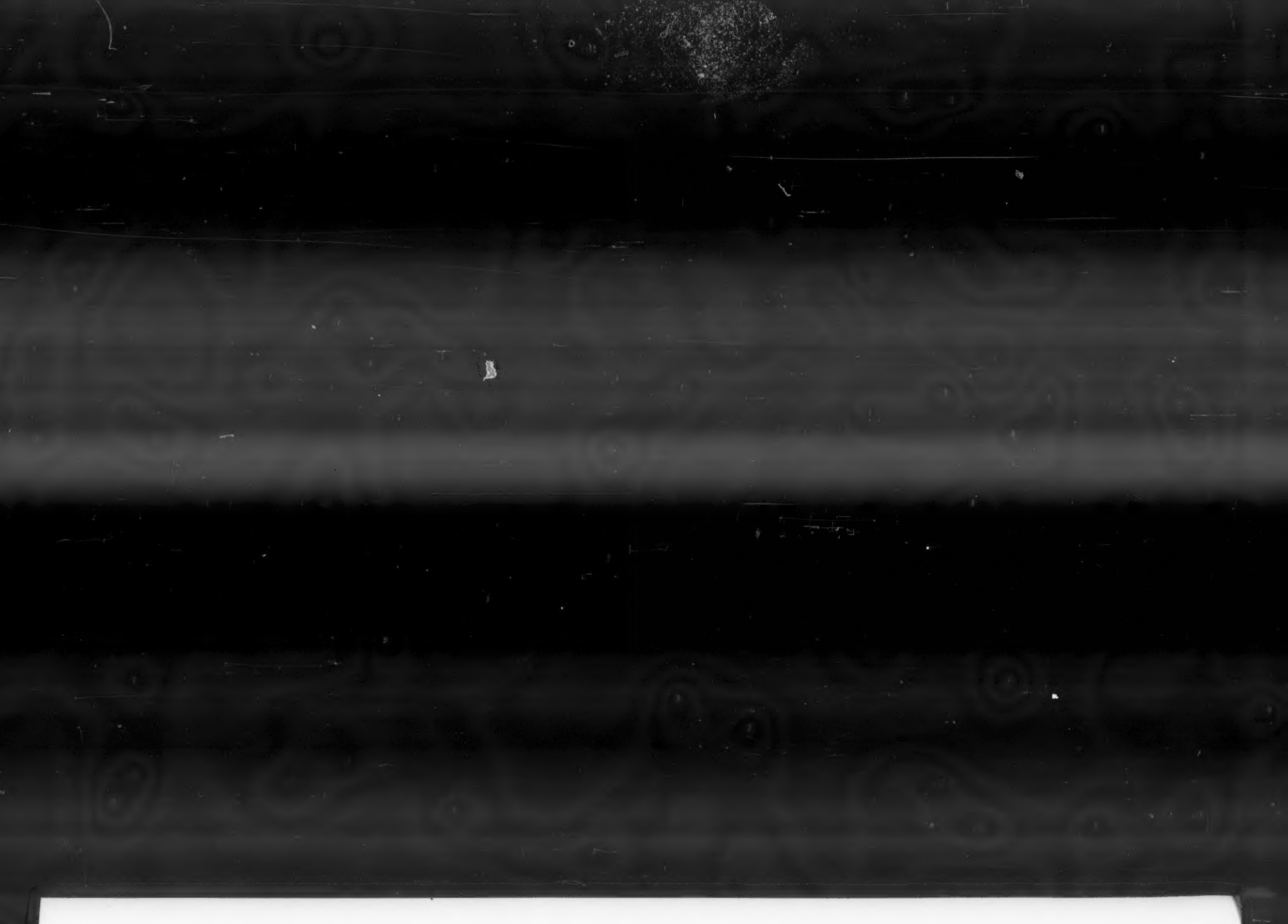

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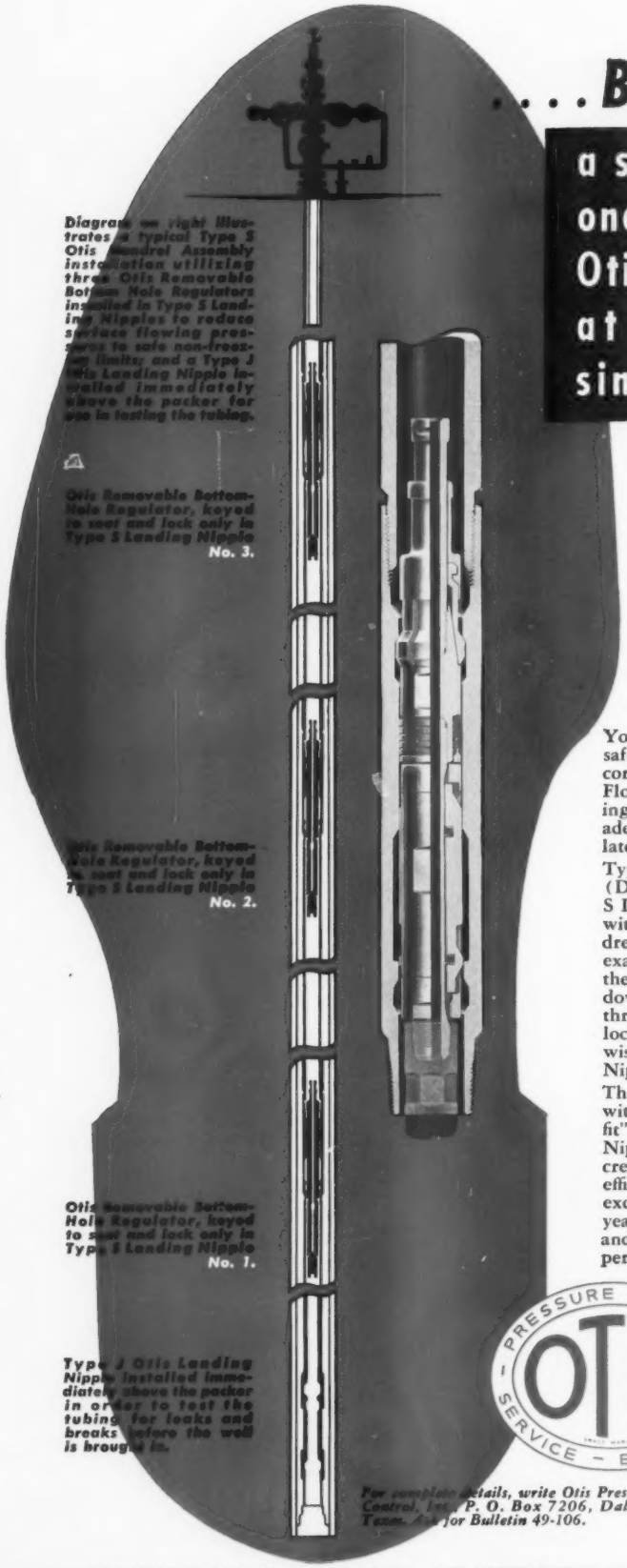

Diagram on right illustrates a typical Type S Otis Mandrel Assembly installation utilizing three Otis Removable Bottom Hole Regulators installed in Type S Landing Nipples to reduce surface flowing pressures to safe non-freezing limits; and a Type J Otis Landing Nipple installed immediately above the packer for use in testing the tubing.

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T.P. 2578

GAS HYDRATES OF CARBON DIOXIDE–METHANE MIXTURES

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ABSTRACT

Experimental data are presented for hydrate formation conditions for gas mixtures of carbon dioxide and methane. Equilibrium constants for carbon dioxide, defined as the mole fraction of carbon dioxide in the gas phase (dry basis) divided by the mole fraction of carbon dioxide in the hydrate (dry basis), were calculated using the equilibrium constants for methane developed in an earlier paper.

INTRODUCTION

A series of papers have been written on gas hydrates, giving temperatures and pressures at which hydrates would form.[2, 3, 4, 5, 6, 9, 12, 13, 15] Vapor-solid equilibrium constants have been developed for methane, ethane, propane and iso-butane[1] by which it is possible to compute for a specific gas mixture the temperature and pressure at which hydrates will form.

Carbon dioxide is present in many natural gases in concentrations usually from 0.1 to 2.0 per cent. It also forms a gas hydrate with water and presumably enters the solid solution when present with a natural gas which is forming a hydrate. The equilibrium constant giving the ratio of the concentration of carbon dioxide in the gas phase to the concentration in the solid phase is required for including the effect of the carbon dioxide when computing the conditions for hydrate formation.

Direct determination of the concentration of carbon dioxide in solid hydrate requires a difficult separation to be made. Therefore, this research resorted to the measurement of the temperature and pressure at which specific mixtures of methane and carbon dioxide would form hydrates. From the equilibrium constants previously mentioned for methane, it is possible to compute the equilibrium constant for carbon dioxide, without measurement of the composition of the solid phase.

Fig. 1 shows the conditions at which methane and carbon dioxide form hydrates. The methane curve FG extents to some high pressure while the carbon dioxide curve AB intersects the vapor-liquid water-liquid carbon dioxide

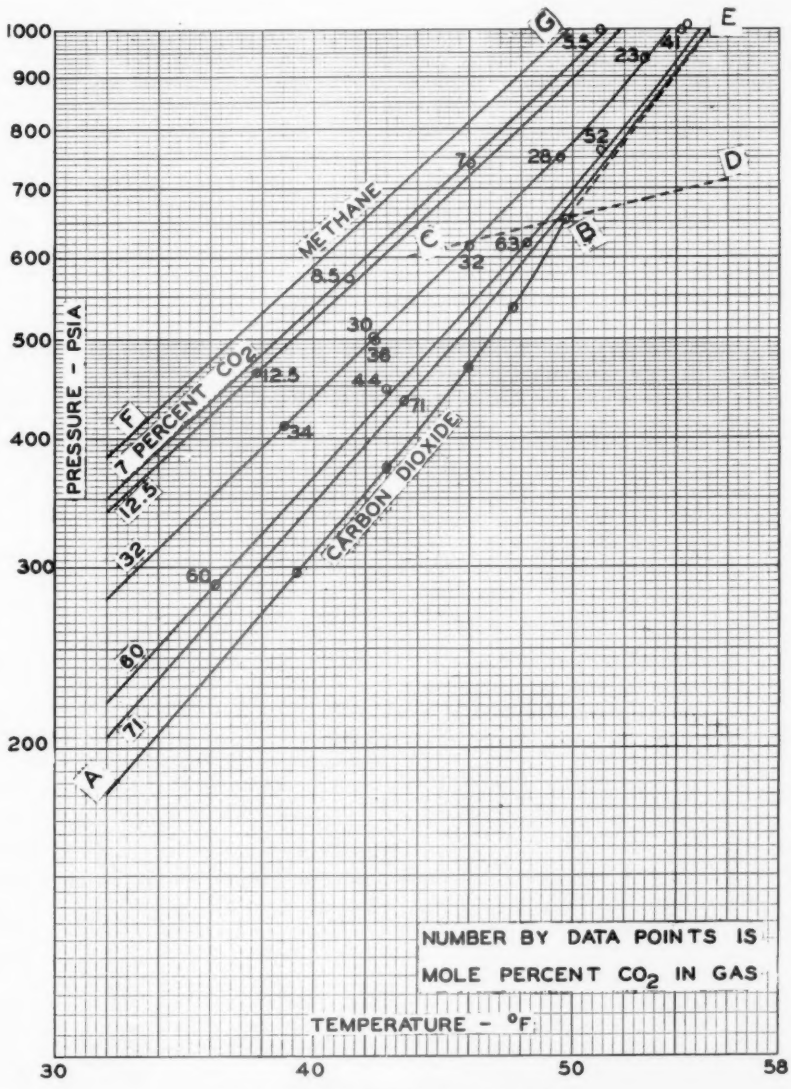

FIG. 1—HYDRATE FORMATION CONDITIONS.

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[1] References are given at end of the paper.

($V\text{-}L_1\text{-}L_2$) curve CD at B, the quadruple point. Curve BE is the locus of conditions at which four phases exist.

EXPERIMENTAL PROCEDURE

The apparatus used was similar to that described by previous investigators[7, 15] with the addition of two gas mixing cells.

These two cells were used to meter carbon dioxide and methane separately by mercury displacement. The amount of each gas added was calculated from the quantity of mercury displaced, the pressure and temperature, and available compressibility factors for methane[11] and carbon dioxide[7, 13].

The gases were then pumped back and forth from one cell to the other several times. The gas was allowed to remain in one of the cells each time for twenty or thirty minutes to permit mixing. This gas mixture was introduced into the hydrate cell.

The hydrate cell had glass windows and was immersed in a constant temperature water bath. The cell could be rotated through an angle of 30° from the horizontal to agitate its contents. The cell was illuminated by means of an electric light bulb placed inside a large glass tube which was immersed in the constant temperature bath.

The hydrate cell was filled with distilled water by means of a pump. The gas mixture was then introduced into the cell, allowing about half the water in the cell to be displaced by the gas. The bath was then cooled by addition of ice to 32° to 33°F. or to 5° or 6°F. below the temperature for hydrate formation. The cell was then agitated until hydrate began to form. As the hydrate formed the pressure observed by a Bourdon gage decreased slowly. The bath temperature was then increased until the hydrate began to melt and the pressure began to rise. The bath was then heated slowly until almost all of the hydrate had disappeared. At this point the hydrate was present as small flakes distributed throughout the liquid phase. The bath temperature was then reduced several tenths of a degree so that hydrate would just begin to form again. The cell, with continuous rocking, was kept at a constant bath temperature and pressure readings were taken every five minutes until no noticeable change in pressure occurred. The pressure and temperature readings were then recorded as the hydrate formation conditions for the composition of the gas in the gas phase. The pressure in the cell was then increased by addition of water by means of a pump, and the procedure was repeated. In this manner three or four points could be obtained for each gas sample.

This procedure made it necessary to calculate the composition of the gas phase. Solubility data for pure carbon dioxide in water[14] and for natural gas in water[8] are available in the literature. These data were extrapolated to the temperature range involved and calculations were made by a trial and error method. A gas composition was assumed and the quantities of each component in the liquid and in the gas phases were calculated. The total gas composition was thus found. If it did not agree with the composition of gas charged to the cell, another assumption of gas composition was made and the calculation was repeated.

HYDRATE BEHAVIOR

Hydrates of pure carbon dioxide exhibited some characteristics different from those of the gas mixtures. Much more difficulty was experienced in getting the pure carbon dioxide to form hydrates than for the mixture. An effective method of getting hydrates to form in a sub-cooled mixture was to lower the pressure suddenly about fifty pounds. The carbon dioxide hydrate formed exceedingly fast and uniformly throughout the water phase. In a few seconds what had been the liquid phase

TABLE 1
PHASE EQUILIBRIUM DATA FOR CARBON DIOXIDE-METHANE-WATER SYSTEM

A. Conditions for Hydrate Formation with Carbon Dioxide-Methane-Water Mixtures.

Run	Point	Temp. °F.	Press. psia	Mole % CO_2 in Charge	Calc. Mole % CO_2 in Gas Phase	Vol. Gas Phase cc.	Vol. Liq. Phase cc.
1	1	38.9	412	53.9	34	47	47
	2	42.3	502		30	38	56
2	1	42.4	498	54.5	36	47	47
	2	46.0	615		32	38	56
	3	49.5	750		28	28	66
	4	52.8	938		23	20	74
3	1	36.2	289	77.7	60	42	52
	2	42.8	447		44	20	74
4	1	37.8	464	27.4	12.5	42	52
	2	41.4	573		8.5	28	66
	3	46.1	740		7	21	73
	4	51.1	1,000		5.5	15	79
5	1	43.5	435	82.4	71	47	47
	2	48.2	620		63	28	66
	3	51.1	765		52	15	79
	4	54.2	1,000		41	8.5	85.5
	5	54.5	1,015		41	8.5	85.5

B. Conditions for Hydrate Formation with Carbon Dioxide-Water Mixtures.

Temp., °F.	Press., psia
39.3	296
42.8	375
45.9	468
47.7	535
49.8	653 (Quadruple Point)

C. Vapor Pressure Data for Water-Rich Liquid, Carbon Dioxide-Rich Liquid, and Vapor

Temp., °F.	Press., psia	Temp., °F.	Press., psia
60.0	750	53.9	693
58.2	735	48.1	639
53.8	692	43.9	604

appeared to be completely solid even though a large excess of water was present. Apparently, the water was trapped in the honeycomb of crystalline hydrate. The pressure did not drop immediately, indicating that the hydrate had formed from the carbon dioxide in solution; but if the bath were not heated immediately, the pressure would drop fifty to seventy-five pounds in twenty or thirty minutes. As the bath was heated and the hydrate began to melt, the pressure would increase again.

The hydrate obtained from the mixture of carbon dioxide and methane formed much more slowly and appeared to be more of a surface phenomena. It would take, perhaps, twenty minutes for the pressure to drop fifty pounds. The hydrate formed in small flakes which resulted in a "slushy" liquid in the cell. As the bath temperature was increased, the pressure rose again. When almost all of the hydrate was melted, the flakes of hydrate would adhere to the glass and glisten so that there was no doubt about hydrate being present.

The hydrate of carbon dioxide is apparently less dense than water because it tended to accumulate at the surface of the water as it was melting from the original solid mass. At the quadruple point much of it would remain at the interface between the water-rich phase and the even less dense carbon dioxide-rich phase. The mixed gas hydrate was generally in the form of flakes and remained distributed throughout the liquid phase.

The methane used in the experiments (minimum purity of 99.0%) was supplied by the Phillips Petroleum Company. The carbon dioxide (estimated purity of 99.5%) was obtained from Pure Carbonic, Inc.

EXPERIMENTAL RESULTS

Data were first taken for hydrates of pure carbon dioxide in order to perfect the experimental technique. Results are given in Table 1(B). They agree very well with the data of Deaton and Frost[5]. The quadruple point, i.e., four phases present, was observed to occur at 49.8°F. and 653 psia. Vapor pressure data were also taken for the system, L_1-L_2-V, and are given in Table 1(C). A comparison of these values with the vapor pressure of pure carbon dioxide as reported in the literature[10] indicates that the pressure of the three phase water-carbon dioxide system is about three pounds higher than that of pure carbon dioxide. However, this may not be significant considering the accuracy of calibrating and reading the pressure gauge.

Hydrate formation conditions for mixtures of carbon dioxide and methane are given in Table 1(A) and on Fig. 1. From these data lines for various compositions were estimated and drawn in. These lines are cross plotted in Fig. 2.

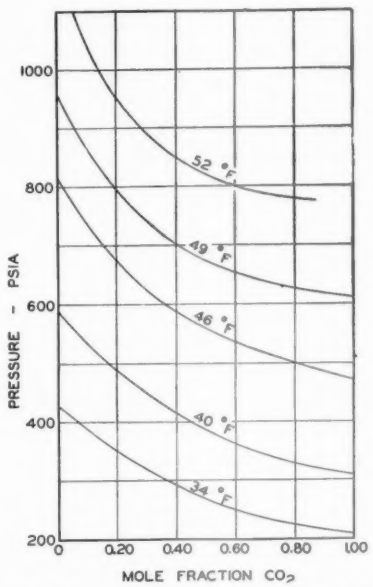

FIG. 2—HYDRATE FORMATION CONDITIONS FOR CO_2-CH_4 MIXTURES.

EQUILIBRIUM CONSTANTS

Equilibrium constants, defined as the mole fraction of carbon dioxide in the vapor (dry basis) divided by the mole fraction of carbon dioxide in the hydrate (dry basis), were calculated and are plotted in Fig. 3. They were calculated using equilibrium constants for methane proposed by Carson and Katz[1]. The hydrate formation conditions which were observed correspond to the dew point in vapor-liquid equilibrium so that $\Sigma x = \Sigma \frac{y}{K} = 1.0$, where x and y are the mole fractions of a component in the solid phase and vapor phase respectively (both on a dry basis). Since the composition of the vapor phase and the equilibrium constants for methane were known, the equilibrium constants for carbon dioxide could be calculated.

To obtain equilibrium constants for carbon dioxide at values above 1.0, it is necessary to have data for a system in which carbon dioxide was the more volatile component. The curve for pure ethane lies at pressures below that for carbon dioxide. It was assumed that a plot of pressure versus mole fraction between CO_2 and ethane was similar to that for CO_2 and methane. This plot and the ethane equilibrium constants were used as a guide in the extrapolation of the CO_2 constants above unity.

The hydrate equilibrium constants for carbon dioxide on Fig. 3 may be used along with the charts for the hydrocarbons[1] when computing the hydrate formation conditions of a natural gas containing carbon dioxide.

ACKNOWLEDGMENT

The previous work and observations on this subject by Mr. Eric R. Kent were of considerable help. The supply of pure methane by the Phillips Petroleum Company was appreciated.

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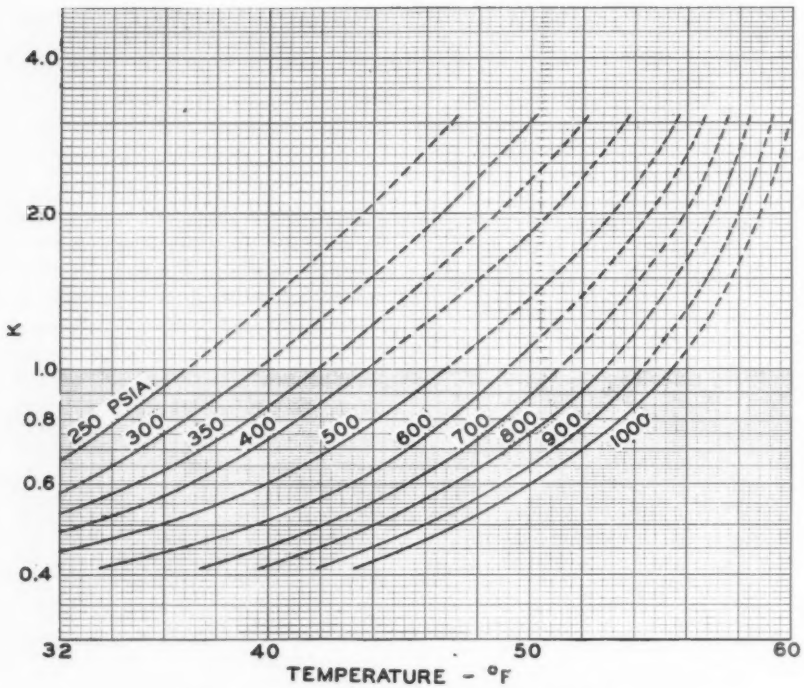

FIG. 3—HYDRATE EQUILIBRIUM CONSTANTS FOR CO_2

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☆

DISCUSSION

By Michael J. Rzasa, Stanolind Oil & Gas Co., Tulsa, Oklahoma

Unruh and Katz have extended our knowledge of hydrates and hydrate-forming conditions by investigating the effects of a non-hydrocarbon component in a binary system. The presence of carbon dioxide in variable concentrations in many natural gases should be taken into account in prediction of hydrate forming conditions in the same way that its presence should be considered when dealing with vapor-liquid equilibria.

Many natural gases contain nitrogen, sometimes in concentrations up to 30 per cent. There does not seem to be complete agreement on whether or not nitrogen forms hydrates with water. I am familiar with a patent granted for the purpose of storing natural gas in hydrate form, in which it is stated that such so-called "permanent" gases as H_2S, CO_2, H_2, O_2, and N_2 do not form hydrates. Actually, the hydrates of CO_2 and H_2S had been investigated as early as 1882 by de Forcrand and Villard[2]. In 1902, de Forcrand summarized known information on gas hydrates in which nitrogen was included as a hydrate with the composition of N_2:4 or 5 H_2O. The above anomaly would seem to point to the need of investigating the possibilities of the existence of nitrogen hydrates and the conditions under which these hydrates may form. The effect of nitrogen on natural gas hydrate- may form. The effect of nitrogen on natural gas hydrate-formation could then be included.

The authors have obtained the gas phase by trial and error computations using extrapolated data for the solubility of carbon dioxide and natural gas in water. The possible errors inherent in the extrapolation process, together with the effect of mutual solubility of the two substances, might result in calculated compositions quite different from experimental. It is realized that analysis of the hydrate is a difficult process, but I would like to ask Katz about his estimate of the possible error involved in the above procedure.

A third point for discussion involves equilibrium constants for the carbon dioxide hydrate which were obtained by using the methane equilibrium constants proposed by Carson and Katz in a previous paper. The methane constants were computed from natural gas hydrates and as a result, might be quite different from the constants for methane in a hydrate system composed of one hydrocarbon and one non-hydrocarbon. For lack of experimental data on the actual composition of the carbon dioxide-methane hydrate, the procedure outlined by the authors is the best available, but it must be recognized that the results may have to be modified with further investigations. ★ ★ ★

GULF OF MEXICO FLOATING DRILLING TENDER

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Drilling operations on the Gulf of Mexico continental shelf are following two general plans. The first plan placed all buildings, equipment, and materials on a large platform while the second copies Lake Maracaibo drilling methods by placing a minimum of equipment on the platform and using a floating drilling tender or drill barge anchored adjacent to the platform in an attempt to take maximum advantage of flotation in an effort to reduce costs.

A complete power rig, mud pits, pipe racks, and small auxiliaries have been placed on the platform as shown in Figure 1, to assure proper handling of drilling operations under the most adverse weather. This has the economic advantages of eliminating the fabrication of a large structure, a material reduction of rigging up time on each structure, and elimination of delay time on equipment while quarters and equipment placed on the tender are being rigged up. These factors have certainly proved their economic value in drill barge operations in the Louisiana and Texas coastal area.

Naturally the heart of such an operation is the anchorage. This anchorage, to permit taking advantage of maximum economies, must hold the ship in a relatively fixed position under the following weather conditions:

(1) Winter northwesters
(2) Southeasterly gales
(3) Severe rain squalls

In hurricane weather all operations must be suspended regardless of method of operation and the floating tender will, if possible, be moved to a protected location. However, in case of an emergency the floating tender should be prepared to swing with the wind and seas on a single anchor as there is considerable doubt that either ship or anchorage could withstand the severe strains imposed by fixed anchorage in hurricane weather.

Northwesters are reported to have developed wind gust velocities as high as sixty miles per hour and steady winds of approximately forty-five miles per hour. Fortunately these winds do not travel a great distance over water before arriving at our location, and, while they can possibly develop seas approximately eight feet high, the waves are short, and if taken on the bow or stern of a ship 250 feet or more in length they should not present a difficult problem.

On the other hand southeast gales having a long fetch and maximum steady wind velocities of approximately thirty miles per hour can possibly develop long swells approximately twelve feet in height. These should develop the most severe anchorage problem. To combat these waves any workable anchorage plan should permit maneuvering the ship in such a manner as to head the bow or the stern into the seas and still maintain contact with the structure.

Rain squalls develop wind gust velocities as great as sixty miles per hour. However, they are local and the seas have not been a source of great trouble. To permit continuous operation the anchorage must be able to withstand these winds broadside to the ship as the wind direction often changes radically in a very short time.

All of these weather conditions are dangerous to small craft, deck cargoes,

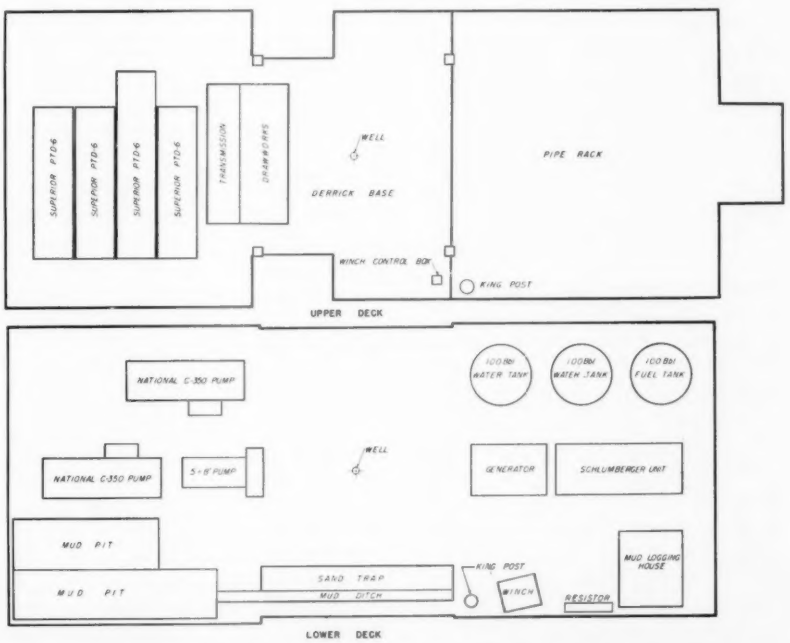

FIG. 1 — LAYOUT OF UPPER DECK AND LOWER DECKS OF DRILLING PLATFORM.

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and improperly anchored barges. However, the objective of the drilling tender method is to develop an anchorage which will permit continuous operation under these weather conditions with the minimum amount of equipment placed on the platform.

As stated earlier it is our opinion that a ship less than 250 feet in length will have considerable difficulty in maintaining anchorage in the heavier northwesters and southeast gales. This fact, coupled with cargo requirements of 2000 to 2500 tons for wildcat wells, limited selection to two war surplus items, Navy YF barges and L.S.T.'s. The latter was selected because of its structural strength, ability to ride heavy seas, greater cargo capacity, availability, and the possibility of self-propulsion. However, the YF barge, among others, has the advantage of shallow draft which will help on locations close to shore.

To accomplish the above objective of continuous operation under all except hurricane weather the mooring must be designed to permit the ship to rise and fall with the waves and to prevent impact loading of the moorings as a result of surging of the ship. No conceivable mooring can hope to withstand the forces imposed by a relatively fixed anchorage if these two requirements are not accomplished. The conditions can be obtained by the use of constant tension mooring winches or by the use of heavy anchor chains. The constant tension mooring winch can be set to maintain a predetermined tension and to pay out line to overcome impact loads in excess of the set tension. Paid out cable is recovered after the severe strain is relieved and the ship is thereby returned to its original position. Heavy anchor chain accomplishes an increasing load and flexibility by lengthening the catenary of the anchor chains suspended in the water. This permits movement and imposes a heavy load which moves the ship back to its original position. If an initial force of reasonable magnitude is applied to either method, impact loading due to surge should be prevented. The magnitude of this force will have to be determined for individual ships and anchorage locations.

After a careful study by a firm of consulting naval architects, 2 1/16" stud link anchor chain was selected as

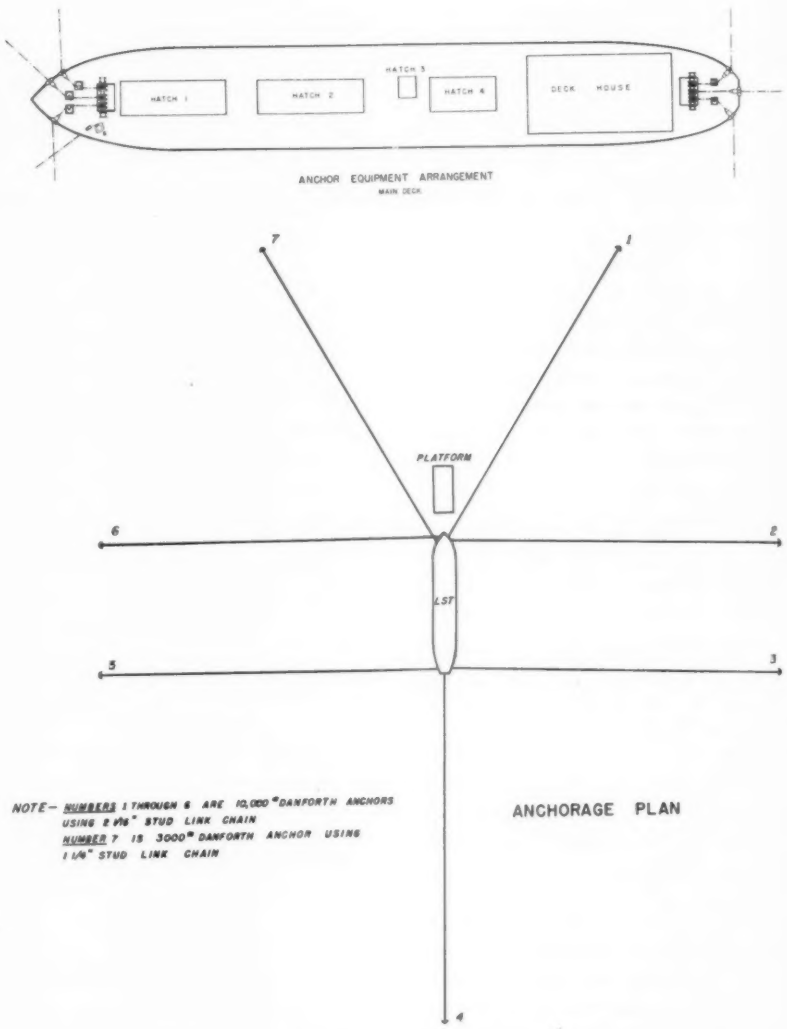

FIG. 2 — LOCATION OF ANCHOR WINDLASSES AND POSITION OF ANCHORS.

being the more positive and less subject to mechanical breakdown. These chains, having an ultimate strength of 341,000 pounds, are stowed in chain lockers and handled by two anchor chain windlasses capable of developing a pull of 120,000 pounds. Each of these windlasses is equipped to handle three chains as shown in Figure 2. The windlass power can be applied to any or all of the chains at one time and each wildcat sheave is equipped with a brake capable of holding 200,000 pounds. In addition to the brake a chain stopped capable of developing the braking strength of the chain is installed on the deck for use after the ship is positioned. The bow chains are ten shots or 900 feet long and the stern chains are twelve shots or 1,080 feet long. The longer stern lines were installed to permit maneuvering the ship to take heavy seas on bow or stern. In addition to these six anchor lines the ship's twelve shot or 1,080 feet long 1¼" anchor chain is used. This line is employed to help balance the bow mooring as the ship is directed toward the structure as shown in Figure 2. To facilitate breaking away from the moorings when a hurricane is approaching, the bitter ends of the chain may be disconnected from the ship.

In conducting these studies wind gust velocities were disregarded as they are of too short duration to overcome the inertia of the ship's mass and transmit forces to the chains and anchors. A

wind load coefficient of .0038 was selected as being a relatively conservative one for the calculation of wind loads on the side of the ship. With an average light draft of ten feet, the total exposed area of deck house and main hull above the water line is approximately 6,510 sq. ft. As this area will not be distributed equally between fore and aft anchor lines with a broadside wind, calculations are based on the assumption that the maximum area attributable to one anchor will be four thousand sq. ft. In addition to direct wind load an allowance of 25% of the total wind load has been made to account for current and surge effect on the anchorage. This was added in accordance with the practice employed by the Navy in the mooring of floating dry-docks in relatively open harbors. Under these circumstances the force imposed on one broadside anchor is as follows:

For a wind velocity of 50 mph the forces are:

Wind load on one broadside anchor:

.0038x4000x50^2	38,000 lbs.
25% allowance for current and surge . .	9,500 lbs.
Total	47,500 lbs.

For a wind velocity of 70 mph the forces are:

Wind load on one broadside anchor:

.0038x4000x70^2	74,480 lbs.
25% allowance for current and surge . .	13,620 lbs.
Total	88,100 lbs.

Another force of unknown magnitude is imposed by the waves. There is no accepted theory or empirical formula for the calculation of wave forces on a moored object. This fact occasioned a decision to keep the ship oriented to receive heavy seas on either bow or stern, thereby exposing a minimum area. To facilitate handling the ship under very difficult circumstances anchor windlass specifications require a maximum line pull of not less than 120,000 pounds.

In selecting an anchor to use in this mooring plan concrete blocks, pile anchors, Navy stockless anchors, mushroom anchors, and patented anchors were considered. For holding power and ease of use 10,000 pound patented anchors were selected. However, to insure against the doubtful and unknown factors involved, pile anchors were installed to back up the patented anchors in the three stern positions in Figure 2. These pile anchors consisted of sixty foot long 14" H-beams driven ten feet below the ocean bed with a length of 2 1/16" stud link anchor chain attached to the patented anchors with approximately ninety feet of slack to permit complete failure of the patented anchors before the pile anchor starts to function. Of course, the holding capacity of anchors varies with the soil characteristics and these vary over wide ranges as indicated by piling penetrations requires at the three locations on Figure 3. To carry identical loads, these pentrations were:

Location No. 1 — 243 feet
Location No. 2 — 196 feet
Location No. 3 — 137 feet.

meager; however, the following general information may be of value. At Location No. 2, Figure 3, one anchor was pulled to the ship in the process of mooring. When this anchor was placed a second time it held; and when the ship was moved after completion of the well, the full power of the anchor windlass applied to individual 10,000-pound patented anchors could not move them. This fact proves a holding capacity of over 120,000 pounds. In an effort to retrieve the 3,000-pound patented anchor, used on the ship's anchor windlass, the three wildcat windlass was secured to it and a sufficient load applied to part a link in the 1¼" chain which has a breaking strength of 129,000 pounds. This indicates a holding power of approximately forty pounds per pound of anchor.

Unfortunately, this condition does not exist at Location No. 1, Figure 3. Soil

FIG. 3 — AREA LOCATION MAP

Equipment is being assembled to conduct anchor holding and chain loading tests and to accumulate data on anchorage forces under various weather conditions. This equipment consists of a calibrated test link equipped with an SR-4 strain gauge, and necessary devil's claws to conveniently install the test link.

As the tests mentioned above have not been conducted, anchorage data is very

samples taken for foundation purposes show a very soft clay to a depth of forty feet below the Gulf bottom. In view of this poor soil quality an attempt was made to determine anchor holding capacities by laboratory tests of soil samples and field tests with a twelve-pound patented anchor. The anchor manufacturer conducted Jurgeson squeeze shear tests on undisturbed soil samples and correlated these with the results of load

tests on 10,000-pound patented anchors in soils of known Jurgeson shear values. The results of these tests were as follows:

Penetration into Gulf bottom	Jurgeson Squeeze Shearing Strength	Probable holding power 10,000-lb. anchor
10 ft.	52 lbs.	55,000 lbs.
30 ft.	116 lbs.	120,000 lbs.
50 ft.	232 lbs.	200,000 lbs.
80 ft.	522 lbs.	300,000 lbs.

These values for probable holding power are not based on reliable data as clay and organic matter content enter into holding power and data available are not sufficient to give more than a rough comparison of soil characteristics. Accurate correlation of soil data is very difficult, if not impossible; therefore, data of the type given above should be considered only as an indication of general conditions. Changes in soil characteristics over a short distance further complicate the problem.

Tests with the twelve-pound anchor were correlated with other available data by the manufacturer to give an estimated holding power of 40,000 pounds for a 10,000-pound anchor. This estimate is also very rough and is therefore considered a good correlation with the 55,000 pounds estimated for a penetration of ten feet by the Jurgenson shear test.

Experience while mooring at this location tended to verify this data as we had no difficulty moving the anchors with the windlasses. Later tests indicate that the anchors have settled to a greater depth and this combined with a consolidation or settling up of the soil around the anchor has increased the holding capacity. We have experienced difficulty in maneuvering the ship or holding it against severe rain squalls. No heavy seas were encountered at this location while the ship was moored.

The capacities indicated at Location No. 1 are not considered satisfactory. However, soil characteristics at this location are very exceptional, even for the Gulf of Mexico Continental shelf. For a comparison with other locations soil analyses indicate no soil shear value which can be interpreted by standard foundation laboratory analyses in the first thirty feet of depth and an average soil shear value for the section from thirty to sixty feet of fifty-nine pounds per square foot. This compares to an average shear value of 112 pounds of soil penetrated at Location No. 2 and an average shear value of 274 pounds per square foot for the first thirty feet of soil penetrated at Location No. 3. The shear values established for foundation purposes were determined by standard compression cohesion tests and the writer has made no attempt to correlate them with the Jurgeson squeeze shear tests.

This data, though sketchy and incomplete, does indicate that anchor holding capacities of reasonable proportions can be developed at Locations Nos. 2 and 3.

The choice of a method for handling dry cargo was another problem that this operation presented. Casing, tubing, drill pipe, well head equipment, dry mud, and cement were the main items of dry cargo which required handling. The dry cargo had to be handled as follows:

1. From the dock to the drilling tender.
2. From the drilling tender to the drilling platform.
3. From barges or boats to the drilling tender.

The gear had to be capable of delivering casing from the drill tender to the platform as fast as the casing can be run into the well.

After carefully checking possible methods, the ordinary ship method of burtoning was selected for the handling of dry cargo. Burtoning is a term used to describe the handling of cargo with two or three booms rigged so that the top of one boom is fixed over the pick-up point and the top of another boom is fixed over the discharge point. The end of the load lines from each of the booms are attached to a common hook. With this arrangement, it is possible to pick up a load vertically under the point of one boom and by hauling in and paying out load lines to set the load down under the point of a second boom. The hook is returned to the loading point by reversing this procedure.

The booms were located as shown on Figure 4. The chief consideration in locating the booms was to arrange them so that all hatches could be reached with a minimum number of standard size booms. You will note that the booms are set off the centerline of the vessel to permit fore and aft burtoning as well as thwartship burtoning. In addition to the ship's booms a single boom was placed on the platform.

The booms were designed for a five-ton load and are fifty-five feet long. The masts or king posts are approximately forty-eight feet high. The cargo winches are rated at a 14,400 lb. line pull at 110 feet per minute, and driven by a 50 h.p. D.C. electric motor.

Burtoning has proved satisfactory in all respects.

The space on the third deck level, aft of the pipe stowage was selected for locating a 7¾"x18" mud pump, a 5"x8" mud pump, and skid mounted cementing unit. The mud pumps and cementing unit are powered by separate Diesel engines. Four of the third deck wing compartments, which are 10'x24' x6'-6" in dimension were utilized for mud pits. A sand trap was mounted in a second deck wing compartment directly over one of the mud pits. Mud was mixed and conditioned on the ship and either pumped to the pits on the platform or directly to the well.

A forty foot long personnel bridge connects the ship and platform. It is hinged on the bow of the vessel so that it is free to move both horizontally and vertically. The other end of the bridge is supported by a trolley attached to an I-beam located under the top deck of the platform. A 15' wide by 12' long hinged ramp extends out from the lower deck of the platform and under the bridge. Hence the bridge is free to move a maximum of twelve feet without destroying the connection between ship and platform.

Liquids are transferred from the ship to platform by means of hose connections. Each hose is approximately 120 feet long. The hose is attached at the bow of the ship to the ship's pipe lines with quick release couplings. The hose extends down into the water, to the ocean floor, and up to the platform where it is coupled into the pipe lines. Hoses are provided for liquid mud, fresh water, salt water, fuel oil, and cement. The hose connections allow a generous movement of the ship without interference to the transferring of liquids.

Power, telephone, and radio cables also extend from the ship to the platform and are rigged similar to the hoses, so that they do not interfere with

a reasonable ship's movement, and so that they can be quickly released.

Quarters are provided on the main deck and second deck for personnel. These quarters consist of eighteen rooms and a dormitory. Each room is equipped to quarter two men and the dormitory has twelve berths. The regular crew is housed in the rooms. Extra labor and service personnel are housed in the dormitory.

Galley and messing facilities are located on the Main Deck. The mess room is equipped with six four-person tables. The method of serving the food is decided upon by the tool pusher in charge. Cafeteria style is the method in use at present.

The communication system is a very important factor in successful operation of the unit. It is possible to talk from the platform to men in the following locations on the tender: mud pumps, cementing unit, generator room, boiler room, forward and stern anchor windlasses, and the office. In addition to this communication system within the drilling unit, two radio communication systems were provided. The principal radio communication system is frequency modulated and provides communication between boats, land base, and the District Office. The second system consists of an amplitude modulated marine radio telephone equipped with channels for Coast Guard, ship to ship, and marine telephone communication. This dual system has been found to be of considerable value due to the lack of complete reliability of radio equipment in the most difficult emergencies.

With the above decisions made, the problem resolved into one of placing equipment, supplies, and personnel on the ship. Figure 4 gives a detailed layout of the arrangement selected. The following materials were loaded on the floating tender for the drilling of the first well:

MUD AND CHEMICALS

4,000 sacks weight materials
136 sacks quebracho
225 100-lb. drums caustic soda
800 50-lb. sacks of lime
600 sacks of drilling clay
600 50-lb. sacks of starch
300 sacks of Kembreak
800 sacks bentonite drilling clay
100 sacks soda ash
100 sacks cellophane flake

DRILL PIPE

415 joints 4½" drill pipe

CEMENT

1,200 sacks slow set cement
1,500 sacks portland cement
1,500 sacks high early strength cement

WELL PIPE

10 joints 16" casing
75 joints 10¾" casing
230 joints 7" 26-lb. N-80 casing
94 joints 7" 29-lb. N-80 casing
69 joints 7" 32-lb. N-80 casing
490 joints 2½" EUE tubing

LIQUID CARGO

225,000 gallons fresh water
170,000 gallons Diesel fuel
40 drums lube oil
and also miscellaneous supplies required for drilling operation.

During the drilling of our first well the crew requirements averaged thirty-five men. The thirty-five men were composed of the following:

1 Tool pusher
2 Drillers
12 Roughnecks
2 Electricians
2 Engineers
3 Able Bodied Seamen
2 Ship's roughnecks
7 Steward's Department
Roustabouts as needed

The crew worked twelve-hour tours, two weeks on and one week off, with the exception of the able bodied seamen who worked eight-hour tours, two weeks on and one week off.

In the drilling of our first two wells we did not lose a single day due to bad weather. However, we did find several periods of twenty-four hours or less when seas were too rough to permit handling drill pipe and dry cargo from ship to platform. Even this most severe weather did not interfere with safe use of the personnel bridge or other communications. While we probably have not operated in the most severe weather, present experience has proved the operation successful. ★ ★ ★

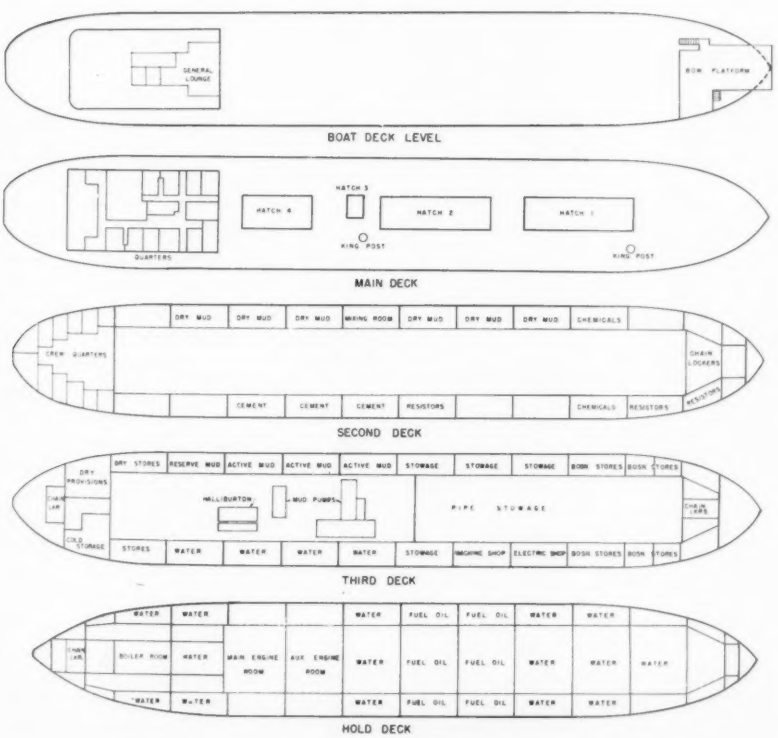

FIG. 4 — LST ARRANGEMENT PLANS FROM BOAT DECK TO HOLD.

T.P. 2589

ESTIMATION OF RESERVES AND WATER DRIVE FROM PRESSURE AND PRODUCTION HISTORY

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ABSTRACT

A study has been made of the material balance-fluid flow method of estimating reserves and degree of water drive from pressure and production history data. By considering the effect of random pressure errors it is shown that in a particular example a standard deviation of three and one-half pounds in each of ten pressure surveys permits the determination of the reserves with a standard deviation of 8 per cent and the water drive with a standard deviation of 15 per cent, assuming that certain basic geologic data are correct. It is believed that this method of estimating reserves and water drive is useful and reliable in a number of cases. The method is particularly valuable when reservoir pressure data are accurate within a very few pounds, but may also be applied with less accurate pressure data if a relatively large reservoir pressure decline occurs early in the life of the field, as for example in an undersaturated oil field.

INTRODUCTION

A knowledge of the magnitude of reserves and degree of water drive present in any newly discovered petroleum reservoir is necessary to early application of proper production practices. A number of investigators have contributed to methods of relating reserves, degree of water drive, and production and pressure history. [1-8] Three types of problems of increasing complexity may be mentioned. If a reservoir is known to have no water drive, and if the ratio of the volume of the reservoir occupied by gas to the volume of the reservoir occupied by oil (which ratio permits fixing the overall compressibility of the reservoir) is known, then only one further extensive reservoir property remains to be determined, namely the magnitude of the reserves. A straightforward application of material balance considerations will permit this determination.[1,6,7] The problem becomes very much more difficult if we wish to determine not only the magnitude of the reserves but also the magnitude of water drive, if any, which is present. In principle, a combination of material balance and fluid flow considerations will permit this evaluation. Finally, if neither the magnitude of reserves, the degree of water drive, nor the ratio of oil to gas present in the reservoir is known and it is desired to determine all three of these variables, the problem could in principle be solved by a fluid flow-material balance analysis which determines the overall compressibility of the reservoir at various points in its history. The change in compressibility with pressure would provide a means of determining the ratio of gas to liquid present, since the compressibilities of gas and liquid vary differently with pressure variation. However, in practice this problem is probably so difficult as to defy solution in terms of basic data precision apt to be available.[4]

It is the purpose of this discussion to illustrate the second case, which involves the determination of two unknown variables, single phase reserves and degree of water drive, from pressure and production history and fluid property data, and to study the precision with which these unknowns can be determined in this manner in a particular case.

Although an electric analyzer developed by Bruce[8] was used in making the calculations to be described, numerical methods necessary in carrying out the process have been devised and have been applied for this purpose.

Schilthuis,[1] for example, developed a comprehensive equation for the material balance in a reservoir. He combined this with a simplified water drive equation, assuming that the ratio of free gas to oil was fixed by geological data and that a period of constant pressure operation at constant rate of production was available to determine the constant for his water drive equation. On this basis he was able to compute the reserves and predict the future pressure history of the reservoir.

Hurst[2] developed a generalized equation permitting the calculation of the water drive by unsteady state expansion from a finite aquifer. He showed in a specific case how the water influx calculated by his equation, using basic geologic and reservoir data to fix the constants, matched the water influx required by material balance considerations.

Old[3] illustrated the simultaneous use of Schilthuis' material balance equation and Hurst's fluid flow equation for the determination of the magnitude of reserves and a water drive parameter from pressure and production history. He used this method to calculate the future pressure history of the reservoir under assumed operating conditions. As a basis for determining reserves, Old assumed a value for his water drive parameter and calculated a set of values for the reserves, using the initial reservoir pressure and each successive measured pressure. The sum of the absolute values of the deviations of the resulting reserve numbers from their mean value was taken as a criterion of the closeness of fit to the experimental data possible with the water drive parameter assumed. New values of the water drive parameter were then assumed and new sets of the reserves calculated until a set of reserves numbers having a minimum deviation from the average was established. The average value of the re-

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[1]References are given at the end of the paper.

serves for this set was taken as the correct value of the reserves and the value of the water drive parameter corresponding to this set was taken as a measure of the water drive.

Woods and Muskat[1] considered four unknowns: the magnitude of the reserves, the ratio of free gas to oil, and two independent parameters to fix water drive. It was indicated that any accuracy reasonably expected of the basic data would not permit the evaluation of the four unknowns. It was also pointed out that the percentage root mean square deviation for the two sets of reserves corresponding to the optimum water drive and to the no water drive case, using Old's data, differed by less than one per cent of the reserves (being 1.51 and 2.16 per cent respectively). However, in the Shuler Field example used by Old and by Woods and Muskat the estimated water drive resulted in a reserves figure which was only 16 per cent less than that which would be calculated assuming no water drive. This relatively small effect of the water drive on the reserve estimate made it difficult to unequivocally evaluate the degree of water drive. It would also tend to minimize differences to be expected in the water drive by calculating the water drive by means of various water drive equations.

The following discussion will assume that two unknowns are to be evaluated, namely, the magnitude of reserves and the degree of water drive. In principle two independent parameters are required to fix the water drive calculation. However, as Old has pointed out, the calculation is relatively insensitive to one of these so that it is felt that it may be determined with sufficient precision in terms of geologic data likely to be available. The remaining unknown water drive parameter has been taken to be the permeability of the aquifer. We feel that it is advantageous to evaluate as well as possible the other field constants and to determine this parameter directly as a permeability in order to keep in mind better the implications of the quantities involved. It is proposed to use as the criterion of the best fit to the experimental data not the deviation of successively calculated values of reserves from the mean value[2] but the best fit of the calculated pressure values to the measured pressure values. This fit was obtained by varying permeability to obtain a minimum standard deviation from the measured pressure values for each assumed reserve value. Again we feel that this will enable us better to keep in mind the implications of the results and in particular to evaluate the deviations of the calculated pressure decline curves from the measured decline curves in terms of precisions likely to be attainable in the pressure measurements.

It may be noted that in the case here selected the water drive is reflected more significantly in the reserve estimate than in Old's case since here there is a difference of about a factor of 1.6 between reserves calculated with the estimated water drive and with no water drive, in spite of the fact that in Old's case the reservoir was 26 per cent depleted and in this case only 5 per cent depleted in terms of reservoir barrels at initial conditions produced per initial reservoir barrel of reserves. The criteria that govern the suitability of any particular reservoir example for determination of reserves and water drive from pressure decline curves are of considerable importance but have not been determined.

BASIC DATA

The example selected to illustrate the procedure and the accuracy of the results which were obtained is a gas distillate field which geological data indicate may be surrounded by a water zone of large extent. In determining the water influx with the electric analyzer the aquifer is in fact assumed to be infinite, and of uniform thickness and permeability. Flow from the aquifer into the reservoir is considered to be radial.

The basic data required for the calculations are given in Table 1. This information may be used with any suitable numerical procedure such as a combination of Hurst's water drive equation and Schilthuis' material balance, or the pressure decline curves may be obtained on the electric analyzer.

TABLE 1
BASIC DATA USED IN CALCULATIONS

h = thickness of aquifer = 38.3 feet
f = porosity of aquifer = 0.3
c = compressibility of water = 6.81×10^{-6} per lb. per sq. in.
μ = viscosity of water = 0.365 centipoise
a = radius of reservoir = 8470 feet
β = compressibility of reservoir gas[a]
$= \frac{1}{\rho}\frac{d\rho}{dp} = 1.87 \times 10^{-4}$ per lb. per sq. in.
(ρ = std. cu. ft. per reservoir barrel of gas)

[a]Substantially constant over small pressure decline considered.

DECLINE CURVES

In setting up the problem on the electric analyzer, the aquifer was divided into concentric zones and an equivalent electrical network was set up, capacitances proportional to the volumes of the zones being connected through resistances inversely proportional to the permeabilities of the zones. An infinite aquifer was simulated by arranging the system so that no appreciable voltage drop occurred on the outer capacitor during the time required to make the analyzer runs. A single capacitor (referred to as the pool capacitor) was used to represent the reservoir expansibility.

For each assumed pair of values of reserves Q and permeability k a complete pressure decline curve was obtained by choosing aquifer resistors corresponding to the assumed permeability and a pool capacitance proportional to the assumed reserves. The system was then charged to uniform initial voltage and current withdrawn according to the production schedule in Table 2, column 2. The reservoir pressure decline is proportional to the voltage decline on the pool capacitor.

In this connection it should again be noted that in principle two parameters are required to define the aquifer performance. In Hurst's equation, for example, one parameter is the argument of the transcendental water drive function and the other parameter is included in the coefficient of the series. In the electrical analyzer one water drive parameter is represented by the electrical resistances in the aquifer (determined from the product thickness times permeability divided by water viscosity) and the other parameter by the capacitances in the aquifer (determined by the product thickness times porosity times water compressibility).

In principle only these products must

be specified rather than the component factors (Table 1). In practice the analyzer runs are found to be relatively insensitive to the value taken for the second product so that geologic data have been used to determine this product. Having determined the second product in this manner, it is possible to use the entire first product or any subgroup as the undetermined water drive parameter. The permeability k has been selected, using the best available values of thickness and water viscosity, because it is subject to large uncertainties, and as previously indicated, dealing with an individual factor rather than an overall parameter affords a check on the reasonableness of the values being selected.

EFFECT OF VARIATIONS IN RESERVES AND PERMEABILITY ON DECLINE CURVES

Taking the value of $Q_r = 83.9$ million reservoir barrels of gas for the reserves and a value of $k_r = 24.3$ millidarcies for the aquifer permeability together with the basic data in the preceding section, a run was made to give a reference pressure decline curve. The pressure changes for this run appear in column 3 of Table 2. Additional runs were then made, varying reserves Q and permeability k. As an example the results of Run No. 1 for $Q/Q_r=1$ and $k/k_r=0.75$ are given in column 4 or Table 2. In each case the variance* σ^2 and standard deviation σ of the variation in calculated pressure from reference pressures at each of ten points on the reference curve were computed. This calculation for Run No. 1 is shown in columns 5 and 6 of Table 2.

For each value of Q assumed, a series of such runs was made using various values of k. To determine the value of k which gave the minimum variance from the standard curve the variance was plotted against k/k_r for each value of Q/Q_r as shown in Figure 1. Each of these curves has a minimum point giving the best value of k/k_r for the value of Q/Q_r for which the curve was obtained. A curve drawn through these minima has a minimum which gives the value of k corresponding to the closest possible fit to the reference curve. In this case, since the reference curve was obtained on the analyzer and contains none of the errors to which field measurements are subject, the minimum variance is zero and the best value of k/k_r is unity. The best value of Q/Q_r corresponding to this value of k/k_r may be found by replotting the minimum points in Figure 1 with the variance σ^2 as a function of Q/Q_r, each point on the curve corresponding to a different value of k/k_r. Such a curve has been drawn in Figure 3, giving of course for the reference curve the value $Q/Q_r=1$.

The curves of Figure 1 were also used as a basis for drawing a series of contours corresponding to given standard deviations on a graph with Q/Q_r plotted against k/k_r as shown in Figure 2. The best values of Q/Q_r and k/k_r are represented by a point at the center of this contour system. It will be noted that the smallest standard deviation which can correspond to a condition representing no water drive, namely $k/k_r=0$, $Q/Q_r=1.64$, is only 3 lbs. per square inch. This would seem to confirm Woods and Muskat's contention that it is impossible by means of an analysis of this type to determine with any accuracy whether or not a water drive is present and what the reserves are. However, the low fluid viscosity and high permeability of this reservoir cause shut-in well pressures to reach reservoir pressure very rapidly, and as has been pointed out[9] by the use of a field calibration technique it is possible to obtain a standard deviation of only 2 or 3 lbs. per square inch for an individual pressure measurement. The random error in an average of a number of check pres-

TABLE 2

CALCULATION OF DEVIATION FROM REFERENCE PRESSURE DECLINE CURVE WITH AND WITHOUT RANDOM ERRORS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Time	Cumulative Production	Reference Pressure Decline[a]	Run No. 1 Pressure Decline[b]	Deviation from Reference	Square of Deviation	Random Errors Added to Reference Curve					Case 1 Reference Pressure	Run No. 1 Deviation in Case 1	Square of Deviation
						Case 1	Case 2	Case 3	Case 4	Case 5			
				(4)—(3)	$(5)^2$						(3)+(7)	(4)—(12)	$(13)^2$
Months	Reservoir Barrels	psi	psi	psi	$(psi)^2$	psi	psi	psi	psi	psi	psi	psi	$(psi)^2$
0	0	0	— 3.9[c]	−3.9	15.2	+2.5	−3.9	+3.9	+0.5	−0.5	2.5	−6.4	41.0
3	187,000	9.5	5.8	−3.7	13.7	−6.2	−2.5	−1.4	−6.2	+3.3	3.3	+2.5	6.3
6	374,000	17.5	14.3	−3.2	10.2	−2.5	−6.2	+0.5	−3.9	+1.4	15.0	−0.7	0.5
9	561,000	25.0	21.8	−3.2	10.2	+6.2	+0.5	+1.4	−6.2	+6.2	31.2	−0.4	88.4
12	1,084,000	48.6	46.7	−1.9	3.6	−1.4	+2.5	−3.9	−6.2	−2.5	47.2	−0.5	0.3
15	1,607,000	69.6	68.8	−0.8	0.6	+0.5	+6.2	−0.5	−2.5	−3.9	70.1	−1.3	1.7
18	2,130,000	88.0	89.1	+1.1	1.2	−0.5	+3.9	−1.4	+2.5	+2.5	87.5	+1.6	2.6
21	2,877,000	116.8	119.7	+2.9	8.4	+1.4	−1.4	+2.5	+3.9	+0.5	118.2	+1.5	2.3
24	3,624,000	142.0	147.1	+5.1	26.0	+3.9	−0.5	+6.2	+1.4	+3.9	145.9	+1.2	1.4
27	4,370,000	165.5	172.6	+7.1	50.4	−3.9	+1.4	−2.5	−0.5	−1.4	161.6	+11.0	121.0
					139.5[e]								265.5[d]

[a] Reference run made at $Q_r=83,900,000$ reservoir barrels, $k_r=24.3$ millidarcies.

[b] Run No. 1 made at $Q=Q_r$, $k=0.75\ k_r$.

[c] Reference case: Variance of Run No. $1=\varphi^2=\frac{139.5}{10}=13.95$

Standard deviation $=\varphi=3.74$ lb. per sq. in.

[d] Case 1: Variance of Run No. $1=\varphi^2=\frac{265.5}{10}=26.55$

Standard deviation $=\varphi=5.16$ lb. per sq. in.

[e] See appendix for explanation of starting point of curve.

* The variance is the sum of the squares of the pressure differences between the two curves at the ten points divided by the number of points (ten). The standard deviation is the square root of the variance.

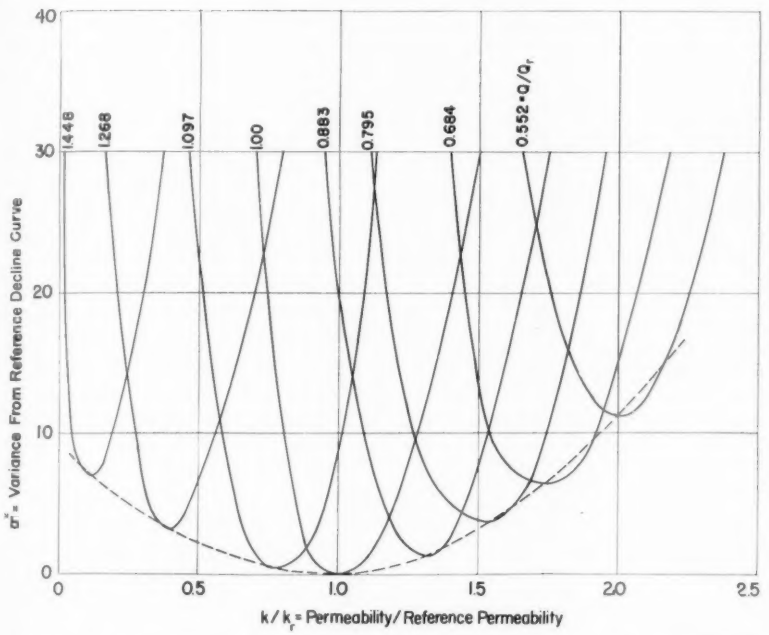

FIG. 1 — EFFECT OF RESERVES AND AQUIFER PERMEABILITY ON VARIANCE IN PRESSURE DECLINE CURVES

Individual solid curves are plotted for values of Q/Q_r (reserves/reference reserves) and give variance (square of standard deviation) of presure decline curve from reference curve versus ratio of aquifer permeability to reference permeability. Minimum point on each curve gives best value of k/k_r for that value of Q/Q_r. Minimum of dashed curve through minima of solid curves gives best value of k/k_r (which is unity when comparing decline curves to reference curve).

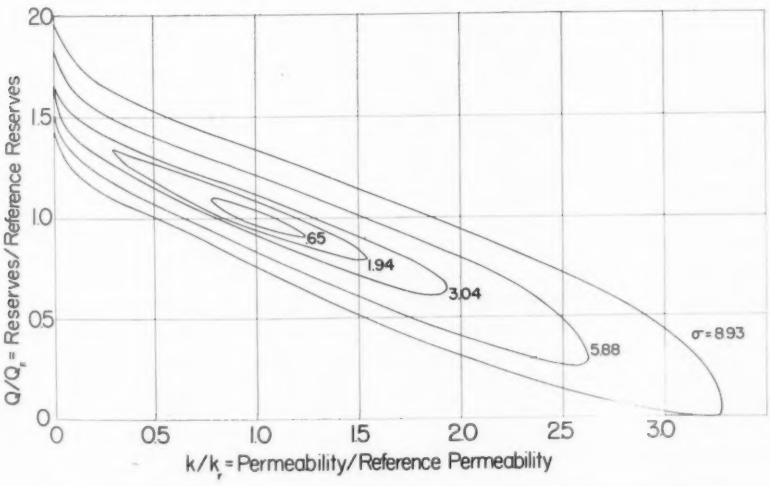

FIG. 2 — CONTOURS OF CONSTANT DEVIATION FROM REFERENCE DECLINE CURVE

The standard deviation σ is the square root of the variance, which is the average of the squares of the difference between a pressure decline curve (for arbitrary Q/Q_r and k/k_r) and the reference curve. The "valley" or point at the center of the system shows the Q/Q_r and k/k_r for which σ is a minimum. Curves on this graph may be obtained by replotting Fig. 1.

sure measurements would of course be less since its standard deviation is that of the individual measurement divided by the square root of the number of measurements.

Further, it should be kept in mind that for the deviations of the random errors in the pressure measurements to give a no water drive (k=0) condition it would be necessary to have a very specialized distribution of these errors. One would not anticipate that a random distribution of errors in pressure measurements would give nearly as wide a dispersion in Q and k as is indicated by the contours in Figure 2, since these represent the maximum variation in Q and k possible with the standard deviations shown.

EFFECT OF ERRORS IN PRESSURE MEASUREMENTS

In order to estimate what the effect of random errors in the pressure measurements might be on the precision obtainable in Q and k the same sets of data were recomputed from new reference curves containing random errors. It was assumed that the true pressure decline was represented by the reference pressure decline curve but that the pressure measurements available had a standard deviation of 3.5 pounds per square inch (which is substantially larger than the deviation corresponding to no water drive, and also substantially larger than the random error of a pressure survey average obtainable for this type of field). Since ten pressure surveys were assumed to be available, a probability distribution was calculated showing what errors would be present in the ten measurements if they were to have the given standard deviation and a random distribution. One of these errors was then assigned by chance selection to each of the ten measurements in the reference pressure decline curves (Cases 1 to 5 in columns 7 to 11 of Table 2 are five different chance arrangements of these same errors).

By adding these errors to the pressures on the reference curve a new reference curve was obtained for each of the five cases, the curve for Case 1 being given in column 12 of Table 2. The same analyzer runs were then used with each new reference curve to determine the variance and standard deviation of each run from the new reference

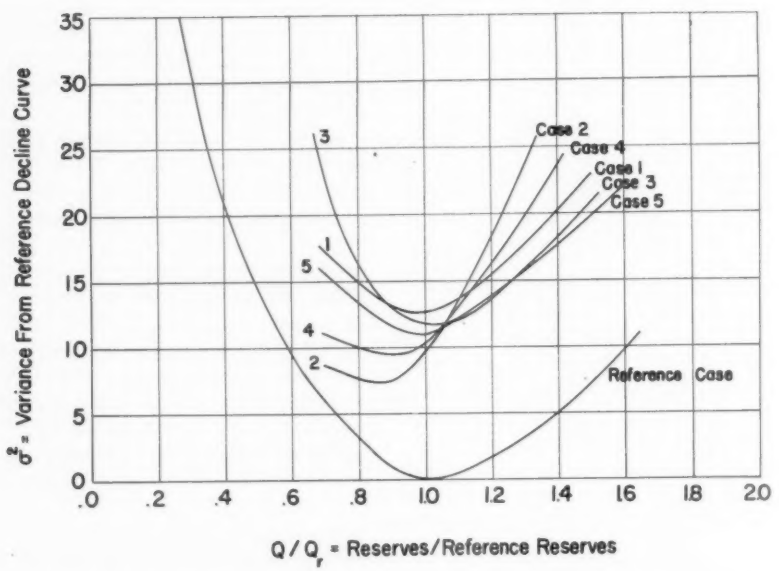

FIG. 3 — EFFECT OF RANDOM ERRORS IN PRESSURE MEASUREMENTS ON ESTIMATION OF RESERVES AND AQUIFER PERMEABILITY

Curve for Reference Case is a replot of data in Figs. 1 and 2 showing the determination of Q/Q_r when comparing decline curves to reference curve. Curves for Cases 1 to 5 are similar plots for chance distributions of random errors in the reference curve (see Table 2 for distributions). Best value of k/k_r for these cases was obtained from a plot similar to Fig. 1 (see Table 3 for results).

TABLE 3

EFFECT OF PRESSURE ERRORS ON ESTIMATES OF RESERVES AND PERMEABILITY

Case	Per Cent Variation from Reference Values: Reserves	Permeability
1	— 2	6
2	—12	21
3	3	— 3
4	— 8	20
5	— 4	4

	Standard Deviation of Individual Values*: Reserves	Permeability
	7.8%	15.0%

	90% Error in Individual Value: Reserves	Permeability
From standard deviation	12.8%	24.9%
From standard deviation	13.1%	25.0%

	Probable (50%) Error in Individual Value: Reserves	Permeability
From standard deviation	5.2%	10.2%
From average deviation	5.3%	10.2%

* Since a small number of values is available, the standard deviation was calculated from the formula

$$\sigma = \sqrt{\frac{1}{n-1}\sum X^2}$$

in which X is one of n deviations.

curve. The calculation for Run No. 1 in Case 1 is given in columns 13 and 14 of Table 2. An entire series of such calculations for the full set of analyzer runs gave data for drawing curves equivalent to Figures 1, 2, and 3 for each case and consequently for determining the values of Q/Q_r and k/k_r for minimum variance. As pointed out for the original reference case, the best value of k/k_r is obtained from a plot like Figure 1 while the best value of Q/Q_r is obtained from a plot like Figure 3. The curves for all five cases are shown with the original curve in Figure 3.

The results for the five cases with random errors introduced are shown in Table 3. The two columns give the per cent errors in estimated reserves and permeability which occurred because of the random errors introduced into the reference curve. These errors, which have a standard deviation of 7.8% in Q and 15.0% in k, correspond to a standard deviation of 3.5 lbs. per square inch in pressure measurement. Restating this in another manner, if the figures for thickness, porosity, field radius, water viscosity and water compressibility are taken as correct, then in this example, pressure survey averages which have a 90% error* of 5.8 lbs. per square inch suffice to determine the reserves with a 90% error of 13% and the permeability with a 90% error of 25%.

While these numbers apply only to the example used, it is felt that they indicate a general usefulness of this method of determining reserves and water drive from pressure and production history. The example here used is generally similar to an actual Frio gas field in Louisiana. The 170 lb. per square inch pressure drop and 5% depletion of the reservoir represent an early period in the history; in general, a longer history would permit more ready determination of reserves and water drive. Relative to the effect of errors in basic geologic data, it should be noted that to a certain extent these will be compensated by changes in k necessary to give the best fit to the pressure decline curve. Although time has not permitted making an exact analysis of the many factors involved in a comprehensive study of the limits of usefulness of this method, it is felt that the material balance—fluid flow approach does offer useful possibilities of estimating reserves and water drive from pressure and production histories in a number of cases.

In this particular case the usefulness of the method depends upon the fact that accurate reservoir pressures are available. This example emphasizes the importance of taking steps to assure the attainment of reservoir pressures accurate within a very few pounds and of developing methods such as build-up curve analysis for correcting for differences between bottom hole pressures and actual reservoir pressures. However, the method is not necessarily inapplicable to all fields where such precision in pressure measurement is not available. In an undersaturated reservoir, for example, a pressure decline of several hundred pounds may accompany the production of a small percentage of the reserves, and larger uncertainties in reservoir pressures may be tolerated without leading to failure of the method.

ACKNOWLEDGMENTS

The authors are indebted to Mr. Phil-

* Defined so that there is a 90% chance that the true value will be within these error limits. The 90% error equals 1.66 times the standard deviation.

lip H. Braun who organized and supervised the project of securing the example given and to Mrs. Mary Hall who obtained the pressure decline curves with the electric analyzer.

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APPENDIX

VERTICAL ADJUSTMENT OF DECLINE CURVE

The drawing of all curves through the initial pressure implies that this measurement is absolutely correct and gives it too much weight. To give all points equal weight, the analyzer runs were first made through the intial pressure and then adjusted vertically to give a minimum value for σ^2. To do this note that any vertical adjustment $\triangle p$ to all the pressures p_1, p_2 . . . p_n on the analyzer curve gives a variance from the reference pressure values p_1', p_2' . . . p_n' equal to

$$\sigma^2 = \frac{1}{n}\sum_{j=1}^{n}(p_j + \triangle p - p_j')^2.$$

To minimize this set the derivative with respect to $\triangle p$ equal to zero,

$$\frac{d\sigma^2}{d\triangle p} = \frac{2}{n}\sum_{j=1}^{n}p_j + \triangle p - p_j') = 0,$$

from which

$$\triangle p = \frac{1}{n}\sum_{j=1}^{n}(p_j' - p_j).$$

The terms are taken with regard to sign, and $\triangle p$ may be either positive or negative.

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DISCUSSION

By E. C. Babson, Union Oil Co., Whittier, Calif.

For those cases where it is necessary to estimate simultaneously the quantity of hydrocarbons originally in place and the strength of the water drive in a pool, the method of analysis developed by the authors seems to offer more promise than previously published methods. It must be recognized, however, that while the authors have somewhat minimized the uncertainties involved in this type of calculation the inherent difficulties still remain. It is, for instance, stated by the authors that the presure decline for the case of no water drive would show a standard deviation of only three pounds per square inch from their reference curve.

While it may be possible to make pressure measurements in wells with sufficient accuracy to render this small standard deviation significant, it is not at all certain that the field pressure data can be interpreted with anything like this degree of precision except under ideal circumstances. Under most conditions it should be possible to estimate the quantity of hydrocarbons originally in place more accurately by the volumetric method than by the method outlined in this paper. Since there are conditions, however, in which it is not feasible to estimate the size of the reservoir by volumetric methods, it may be pertinent to examine briefly the factors involved in some of these cases.

Probably the most common case of uncertainty regarding the volume of the reservoir is that of a pool which has been only partially developed. In this case, however, it is doubtful whether a more reliable result could be computed by the method developed in this paper unless it can be assumed that the pressure in the undeveloped portion of the reservoir is the same as the pressures actually measured in the wells. It is apparent that the uncertainty introduced by this, or any other reasonable assumption regarding pressure in the undeveloped area, can be many times three pounds per square inch and is likely to be in the same direction at all points of the pressure decline rather than having a random distribution. If it is desired to draw conclusions regarding the strength of a water drive during the early stages of development, it would seem advisable to utilize regional geological information regarding the continuity and the permeability of the reservoir rock rather than relying upon materials balance calculation.

Another source of uncertainty regarding the quantity of hydrocarbons originally in place results from the fact that portions of some producing formations may either be barren of hydrocarbons or may have such low permeabilities that they are not effective from the standpoint of production. Unfortunately, lithologic changes which result in these conditions are often gradational and there may be intermediate portions of the formation in which the permeability is high enough for appreciable production of oil or gas but is still too low to permit rapid equalization of pressure when the wells are shut in. Estimates of the reservoir pressure can, of course, be made from built-up curves, but there is always some uncertainty involved in these estimates, and even if the pressure is allowed to build up for a period of weeks, the significance of this pressure is still uncertain if there is reason to believe that there are pressure differences between various portions of the producing interval. It would seem much more desirable to estimate the effective hydrocarbons in place by the utilization of core analysis, electric logging, and flow meter surveys in producing wells rather than

by the use of materials balance methods unless it can be assumed that water encroachment is negligible.

Further uncertainties can be introduced into the reservoir pressure calculation by differences in pressure and in the sub-sea position of gas-oil or water-oil interfaces in the individual wells. If the pressures vary materially from to well it immediately becomes necessary to devise some method of weighting the pressure from the individual wells to give a representative average pressure. While there are several reasonable methods of so weighting pressures, there is always some uncertainty regarding the pressure distribution in the areas between the wells when the pressures in the wells themselves vary materially. If the producing formation has appreciable closure it becomes necessary to project pressures to some datum plane and varying gas-oil and water-oil interfaces in the individual wells cause uncertainty regarding the well pressure which should be used as the basis for projection and the gradient on which the projection should be made to the datum plane. There are several different theories on this problem, none of which seem to give entirely satisfactory results in all cases. In most cases the uncertainties resulting from these factors will not be large but could well be of the order of several pounds per square inch.

There are undoubtedly cases where the method of analysis developed in this paper will furnish information useful in the control and operation of an oil pool. When this method is used, however, the possible uncertainties should be kept constantly in mind and an effort should be made to check the conclusions, at least approximately by some independent method.

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DISCUSSION

By Morris Muskat, Gulf Research & Development Co., Pittsburgh, Pa.

The paper by Brownscombe and Collins presents an interesting study of the possibilities of determining simultaneously the oil reservoir hydrocarbon content and effective permeability of the supporting aquifer, in partial water drive systems, by comparing observed and predicted pressure histories. While the authors refer incidentally to their use of the electrical analyzer as a convenient tool in making the required flow calculations, it is felt that their results are especially pertinent to a general evaluation of electrical analyzer studies or equivalent reservoir treatments. For it has been common practice also to use in such studies the degree of agreement between the calculated pressure histories and those observed as the criterion of validity of the assumed aquifer characteristics. The use in the latter of the fluid expansion capacity and permeability of the aquifer as the two adjustable parameters and the variation of the oil reserves and aquifer permeability, as applied in the present paper, are essentially equivalent from an analytical standpoint. In fact, one could go still further, and in some cases more appropriately, and vary the oil reserves and fluid expansion capacity of the aquifer, keeping the average permeability fixed, and very likely obtain equivalent results regarding the poor sensitivity of the pressure predictions to the exact values of the reservoir parameters.

As to the quantative aspects of the treatment, the significance of the magnitude of the deviations between the calculated and measured pressures will depend largely on the accuracy of the recorded pressure data and the physical significance of the individual values. The authors properly point out that to apply their method very high precision in the pressure determinations will be required. But the problem is more than one of gage accuracy and depth correction. It involves the perennial plague of pressure averaging. This may be especially serious during the early producing history where the effective reservoir volume is being continually enlarged until the field is fully developed, with corresponding changes in the significance of the various pressure averages. On the other hand, later in the producing life the development of pressure differences over the field—often by several hundred psi—will again lead to uncertainty as the true precision of pressure averaged with or without weighting. While these complications will be smaller in distillate or gas cap reservoirs, it would seem that to base the determination of the magnitude of water intrusion and reserves in most oil reservoirs on differences in mean pressure deviations of 1-3 psi would severely tax one's faith in conventionally reported reservoir pressures.

Referring specifically to Fig. 1 of the paper, it will be seen that by choosing the permeability to be twice the reference or correct value the root mean square pressure deviation between the theoretically accurate reference pressure history and that calculated will be only about 3.5 psi, even though the assumed reserves be only 55.2% of the correct value. Conversely, one may take the reserves to be 44.8% greater than the correct value and still get agreement between the true and calculated pressure histories such that the root mean square deviation does not exceed 2.7 psi, by adjustment of the permeability parameter. Thus throughout a range of total variation of 88.6% in the reserves, and a factor of about 10 in the corresponding rates of water intrusion, it is always possible, for the system treated in the paper, to reach agreement between the supposedly true pressure history and those computed to within 3.5 of psi, on the average, for the production interval used in the analysis. It would appear, therefore, that the resolution or discriminating power of this method of treatment is subject to essentially the same limitations as are inherent in those previously developed from material balance principles. While this might have been anticipated qualitatively from earlier studies of the general problem of reserves estimation, the quantitative treatment of the authors does provide more specific esimates of the effects involved.

Author's reply to Morris Muskat and E. C. Babson:

The importance of securing accurate average reservoir pressures has been emphasized both in the preceding comments and in the original article. Both Muskat and Babson have outlined some of the difficulties and uncertainties attending the securing of such pressure data. While there are cases in which average reservoir pressures will be so unreliable as to rule out the material balance method of estimating reserves and water drive, it is believed that the accuracy will be sufficient to give useful results in a number of instances.

Muskat has suggested that the

method is less applicable to oil reservoirs than to gas reservoirs because of the greater uncertainty in average reservoir pressure. On the other hand, a greater uncertainty can be tolerated with an undersaturated oil reservoir since a larger pressure decline will accompany the initial period of production by liquid expansion, and hence a smaller fractional error in reservoir pressure decline will result from equally accurate absolute pressure measurements.

An important consideration is the fact that calculated decline curves are compared with reservoir pressure decline rather than with absolute reservoir pressures. Viewed in this light some of the problems of pressure estimation become less intractable. For example, as Babson has pointed out, in a relatively undeveloped field it is necessary to make assumptions about the pressure in the undeveloped area, and these assumptions may lead to errors which are likely to be in the same direction at all points of the pressure decline rather than having a random distribution. Pressure errors which are all in the same direction, however, would have less effect on reserve and water drive estimates than randomly distributed errors, since the calculated decline curves are vertically adjusted to secure the best possible fit. In fact, if the errors were all equal and in the same direction they would have no effect on the reserve and water drive estimates.

Further, with regard to the ever-present problem of averaging the well pressures to secure an accurate reservoir pressure, while it is very difficult, as both Babson and Muskat have pointed out, to devise a system of weighting the individual pressures which will produce a good absolute pressure in all cases, it is much simpler to find a system of weighting which will give a good approximation of the pressure difference existing between surveys made at different times. For example, a good approximation to such a system may be simply to use the same wells and the same system of weighting for all pressure surveys. This procedure might begin to break down as the field is depleted but the longer pressure history thus made available would be a compensating factor.

On the other hand, the question of non-uniform permeability raised by Babson is not readily answered by material balance methods. If a portion of the formation is extremely tight and contributes little production during the early history, it will be missed by a material balance reserve estimate. If the developed portion of the field is entirely surrounded by a very tight section which has experienced negligible pressure decline then no water influx will have occurred and both the reserves and the water drive will be underestimated. Other work by the authors, however, indicates that even in a tight formation of a few milldarcies the pressure will soon decline at substantial distances from the producing area.*

It should be pointed out that the abbreviated statistical analysis given in the article does not cover all cases and that too much significance should not be attached to the quoted standard deviation of 3.5 lbs. per sq. in. The primary point of the analysis is to indicate that while an error of say 3.5 lbs. per sq. in., if properly chosen, could make a large difference in the results, the chances are that the natural distribution of such pressure errors will affect the results to a much smaller extent than that indicated by Muskat. For the example given it is believed that a 3.5 lbs. per sq. in. precision in pressure measurement would lead to worthwhile results. Other cases would of course require greater or less precision depending upon pressure decline, degree of water invasion and other factors. A quantitative answer to this more general question would require a much more comprehensive statistical analysis than has been attempted by the authors.

★ ★ ★

* Miller, Kieschnick, and Brownscombe: "The Effect of Production Rate Upon Ultimate Recovery from a Solution Gas Driven Reservoir," presented at the AIME Meeting in Dallas October 6, 1948.
and
Brownscombe and Collins: "Steady States in Single Phase Reservoirs," presented at the AIME Meeting in San Francisco, February 16, 1949.

T.P. 2591

RELATION BETWEEN PRESSURE AND RECOVERY IN LONG CORE WATER FLOODS

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ABSTRACT

Conclusions drawn by previous research workers with respect to the relation between pressure gradients and/or velocity and oil recovery obtained by laboratory water flood tests have been in disagreement probably due to variable procedures and unnatural conditions and materials. The Bradford Laboratory of the Pennsylvania Grade Crude Oil Association as part of its secondary recovery research program has conducted nineteen water floods on two long cores of widely differing characteristics in an attempt to clarify this relationship and make it an aid in predicting flooding pressures in the field. Unlike previous research procedures the present experiments were conducted with the aim of duplicating field conditions as closely as possible by using long unextracted consolidated cores, a live crude, and natural brines for both flooding and connate water content. Also, the pressure gradients and flooding velocities were representative of field conditions where similar sands were being flooded. Eleven floods on one core and eight floods on the other core showed increased recoveries and lower residual oil saturation with increased flood pressure gradients and flood velocities. A marked decrease in recovery was obtained from both cores at very low flood velocities. This pressure versus recovery relationship is shown to hold up to the point of water breakthrough and also up to the 100 and 1 produced water to oil ratio point.

INTRODUCTION

The possibility of water flooding oil sands was suggested by Carll of the Pennsylvania Geological Survey in 1880. It is not known when the practice was tried intentionally for the first time, but its beneficial effects were noted in the annual production rate of the Bradford field as early as 1907. The practice was illegal in Pennsylvania until 1921. Early water floods in the Bradford field usually consisted of shooting or splitting the casing secretly to permit subsurface waters to enter the producing sands under hydrostatic head. As it was noted that the benefits of water flooding seemed to be proportional to the quantity of water dumped into the well many also began to utilize surface sources after the practice became legal. It was probably during the middle 20's before many producers realized that the pressurehead of the water upon the producing sand determined the rate and quantity of water that would enter the sand. Hence, rate and quantity of production appeared to be a direct function of input pressures.

By 1927 a few producers had ventured the installation of pressure pumps in order to increase water-input rates and production through the combination of hydrostatic and hydraulic pressures. The adoption of pressure flooding and the "five-spot" drilling pattern in the Bradford field were essentially simultaneous. Water-input pressures in 1930 seldom exceeded 300 p.s.i. at the well head or 1100 p.s.i. at the sand face. Since that time, water-flood producers in the Bradford-Allegany fields have gone to higher and higher pressure until today 600 p.s.i. at the well heads is called a low pressure flood. Many high pressure floods now operate at 1300-1400 p.s.i. at the well head. The limiting and advisable pressure at the sand face has been pronounced as that pressure just under what is required to lift the overburden or to cause formation parting.[1] According to this rule any water flood operation utilizing well-head pressures nearly equal in pounds per sq. in. to 1.1 times the average depth in feet to the top of the producing sand would be considered as a high-pressure flood.

Despite the higher pressure trends in the Bradford-Allegany field operations and the results of early laboratory water flooding research, the desirability and benefits of high input pressures are still questioned by many operators, particularly in midwestern water flood operations.

The present paper recounts a series of 19 laboratory water floods using two long, consolidated cores of widely differing characteristics saturated with live crude and flooded with oil field brines in an effort to simulate field conditions under various pressure gradients and flooding velocities. For both cores, higher recoveries and lower residual oil saturations were obtained at higher pressure gradients and flood velocities. This relationship is shown to hold up to the water breakthrough point and also up to the 100 to 1 produced water to oil ratio point.

Manuscript received at Petroleum Branch Office February 2, 1948. Paper presented at AIME Annual Meeting, New York City, February 16-19, 1948.
[1] References are given at end of paper.

REVIEW OF LITERATURE

Umpleby,[1] upon noting a marked increase in oil production rates caused by "dumping" wells nearer the producer, called attention to the beneficial effects of higher pressure gradients in 1925. Two years later Torrey[2] credits H. M. Ryder with having demonstrated in the field that the amount of water an input well would take was dependent upon the hydrostatic pressure of the water in the well bore. Producers in the Bradford-Allegany field at that time believed decreased development costs by wider spacing of wells to be the chief advantage of using higher input pressures. Russell,[3] in 1932, as a result of laboratory tests, found it difficult to predict whether or not more oil would be recovered by higher pressures while maintaining constant well spacing.

Ryder[4] as a result of field experiments and related observations and interpretations of laboratory floods conducted by Yuster at The Pennsylvania State College was probably the first to proclaim the benefits of higher flooding pressures upon recoveries. For more than a decade he has been the chief advocate of high flooding velocities,[5,6] which for any given sand are a direct function of pressure gradient. His latest contribution,[7] based upon field experiments, showed that on four Bradford oil properties, each of eight increases in the water pressure resulted in a substantial increase in the quantity of oil ultimately to be produced.

Parsons[10] obtained greater recoveries at lower pressure gradients when flooding verticle unconsolidated sand columns where gravity separation became a factor. However, Miller[11] showed increases in recovery with higher flooding pressures and velocities in laboratory experiments using horizontal packed unconsolidated sand columns. Yuster,[8,9] and Calhoun, McCormick, and Yuster,[13] have reported increased flooding efficiency with respect to higher pressures in laboratory floods of low permeability consolidated sand cores from the Bradford-Allegany field. Later, Morse and Yuster[14] in reporting upon 42 laboratory water flooding tests on three different long Venango sand cores from the Franklin, Pa., mine of widely varying permeabilities found that with the materials used there was no measurable effect of flooding gradient or velocity upon residual oil saturation. Holmgren[15] recently reported on ten laboratory water drives at various pressure gradients using a long, high-permeability, consolidated core cut from sands outcropping near Sand Springs, Oklahoma. The core contained connate water and free gas throughout all tests. Holmgren concluded that for the range investigated, the water input rate and the resulting pressure gradient, during a water drive at low gas saturation, has no discernible effect on the final oil saturation of the core.

A paper by Earlougher,[12] based upon many laboratory floods of cored sands and related field observations has been widely accepted by water flood producers and research workers as indicative of what is to be expected under field operating conditions. He has concluded that:

1. For any given oil saturation there is a critical maximum velocity above which the recovery efficiency falls off rapidly.
2. When this critical velocity is exceeded, the water-oil ratio rises extremely fast and thus shortens the economic life of the flood and in turn reduces the ultimate recovery.
3. The critical velocity of a sand varies with the percentage of oil saturation, with sands of higher saturation having higher critical velocities.
4. Recovery efficiency by flooding is largely dependent upon two factors; namely, percentage of oil saturation at the beginning of the flood and the velocity of the flooding water.

APPARATUS AND MATERIALS

Cores

One of the cores used in these flooding experiments was obtained from horizontal drilling in the Franklin, Pa., oil mine into what is locally called the First Venango sand. It was a cylindrical core approximately 4¼ inches in diameter and 51 inches long. The sandstone was well consolidated and had a nitrogen gas permeability of 135 millidarcies without extraction. Before the first crude saturation the brine permeability was measured as 49 millidarcies. After repeated saturations and measurement of the total fluid content, its porosity was estimated at 18 per cent. The core was not extracted or treated in any way before mounting nor during any of the tests.

The second core was very similar to the Third Bradford sand. It was taken from a sandstone outcrop corresponding strati-

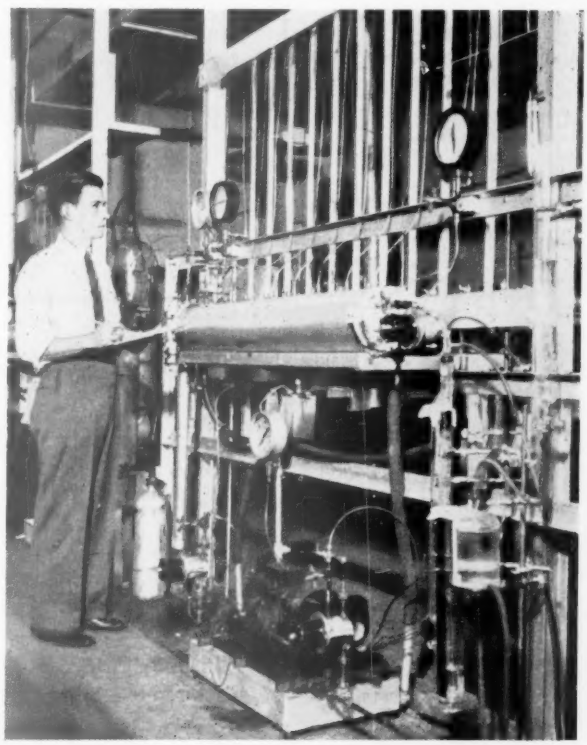

FIG. 1 — CORE FLOODING APPARATUS.

graphically to the Third Bradford sands at Rushford, New York, approximately 45 miles northeast of the Bradford field. It was cut to cylindrical shape approximately 4¼ inches in diameter and 12 inches long. The core had a measured air permeability of 15.3 md. and a brine permeability of 2.55 md. The porosity was determined as 16.9% by the sand grain density method. This core also was not extracted or treated in any way before mounting or during the experiments.

Core Mountings

Very shallow circumferential grooves were cut at eight locations along the Venango sand core and taped with cellophane tape. These were to simulate piezometer pressure rings. The core was coated with a polystyrene lacquer and mounted in hard sealing wax in 4½-inch steel pipe. Using the proper gaskets to completely isolate the core from the wax, end plates with two openings each were bolted to the ends of the pipe. The pipe and wax were tapped down to the piezometer rings and special fittings and valves inserted to complete the pressure taps into the mounted core.

The core mount was fitted with a jacket through which could be circulated water at a constant temperature.

The mounted core was placed on a steel rack, as illustrated in Fig. 1, and fitted with the auxiliary equipment. Saran plastic tubing and brass fittings were used wherever possible. Plastic tubing was also used for the U-tube pressure manometers. The manometers were connected to give the pressure gradients over nine sections of the core and the overall pressure drop.

Sufficient auxiliary equipment was installed (see Figs. 1 and 2) to allow for oil saturations and brine floods and for continuous measurement of all fluids going into and out of the core. This provided the necessary data for a continuous and absolute material balance on the core.

The Rushford sandstone core was mounted in 4½-inch steel pipe with hard sealing wax the same as the Venango core except that there were no pressure taps installed. The core was mounted on a rack and fitted with auxiliary equipment necessary for saturating and flooding. Equipment on a smaller scale than for the Venango core was provided for obtaining the necessary data for a material balance on the core. For this core provisions were made for disconnecting and weighing the core before and after each saturation and flood.

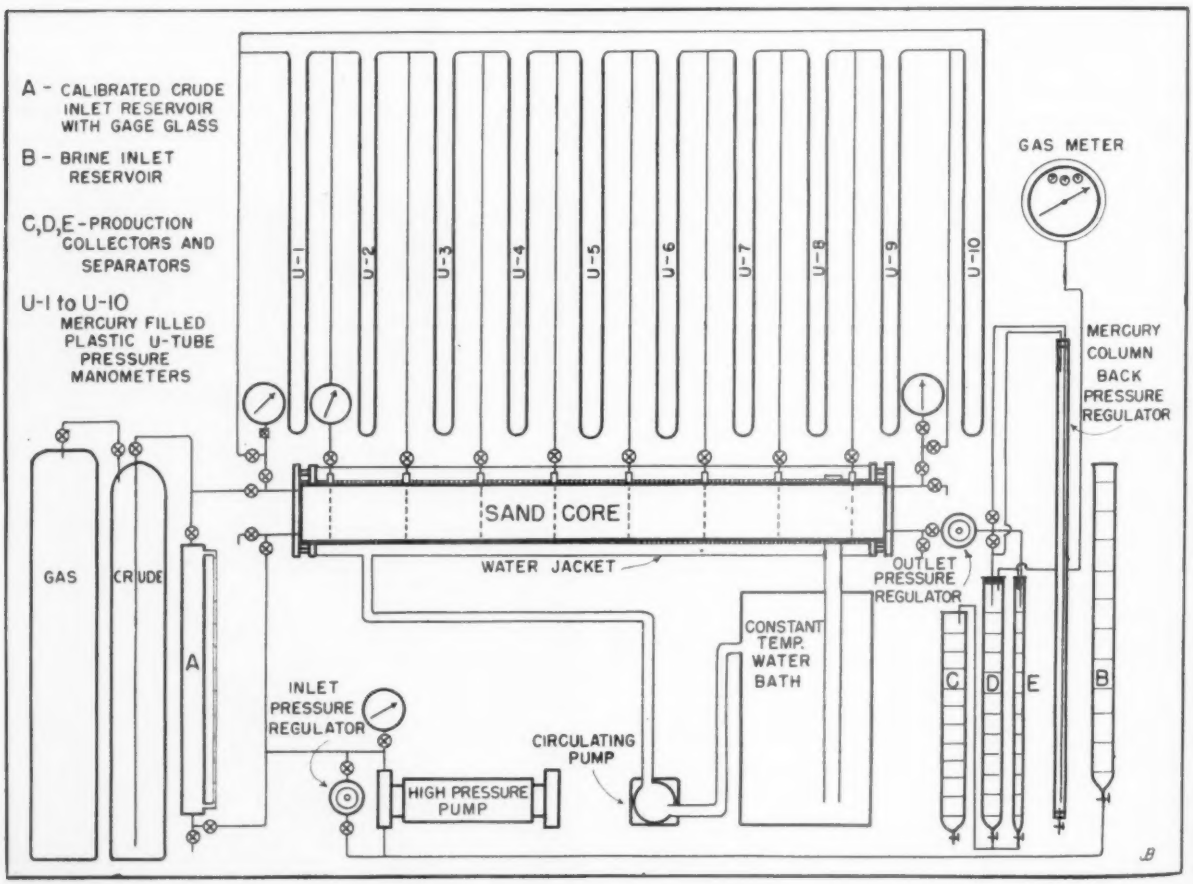

FIG. 2 — DIAGRAM OF CORE FLOODING APPARATUS.

Saturating and Flooding Materials

The crude oil used in the experiments on both cores was a live Bradford crude with a specific gravity of approximately 0.80. The crude used in the Venango core was gassed-up with natural gas to a bubble point of approximately 20 p.s.i. The crude used in the Rushford core was gassed-up to a bubble point of approximately 10 p.s.i.

Pressure pycnometer measurements showed that in depressuring the live crude from 20 p.s.i. gauge to atmospheric pressure one liter of evolved gas (standard conditions) would account for a shrinkage in oil volume of 1 milliliter. This factor was used in correcting the produced oil volumes for shrinkage due to release of dissolved gas from the produced crude.

The brine used to saturate and flood the Venango core was a produced water from the Franklin mine from which the core material was obtained. It was natural brine diluted with fresh water to a specific gravity of 1.016. The chloride content measured 12,000 ppm. Except for clarification by filtering and settling the brine was untreated.

The brine used to saturate and flood the Rushford core was a strong natural brine produced by a Bradford oil well. It had a specific gravity of 1.126 and a measured chloride content of 127,000 ppm. It was clarified by settling, and kept from contact with air as much as possible.

The gas used to pressure-up the crude was a dry natural gas from the Bradford oil field.

OPERATING PROCEDURE

Saturating Cores

Except for determining the gas permeability, the cores were not subjected to any artificial preparation (such as extracting) before saturating. The first saturation was made with brine on the evacuated core. Brine was pumped in under pressure while a vacuum was pulled on the outlet end and pressure taps. After the brine came through the core was flooded with brine at a high pressure gradient until the increase in brine content of the core became negligibly small. The core was then ready for saturating with crude.

Saturating the Venango core with a live crude was performed as follows: The calibrated crude oil reservoir "A" in Fig. 2, was first loaded with brine. Then the brine was displaced by crude from the crude storage cylinder which in turn was displaced by gas from the gas cylinder. For obvious reasons, these operations were carried out under a pressure always in excess of the bubble point of the crude. Next, the crude was driven into the core by displacing it from the calibrated reservoir with brine from a high pressure pump. A back pressure slightly in excess of the bubble point of the crude was kept at the outlet end of the core by means of a diaphram and spring action back pressure regulator or by a mercury column through which the produced fluids had to flow. The produced fluids were collected, separated, and measured in the apparatus illustrated. The crude saturation was continued until several pore volumes were flowed through at which point the brine saturation was reduced to a minimum, and only a negligibly small amount of brine was produced for each volume of crude. A complete material balance permitted the calculation of the oil and brine content of the core.

The Rushford core was saturated with crude in the same manner as the Venango core. The oil and brine contents were calculated by material and weight balance, provisions having been made to weigh the core before and after saturations.

Flooding Cores

The cores were flooded by pumping brine from an inlet reservoir into the core and collecting and measuring the produced fluids in the appropriate receivers (see Fig. 2). The flooding was performed at predetermined pressure gradients which were obtained by regulating the inlet pressure with a constant pressure regulator.

The Venango core was saturated with crude and then flooded with brine eleven different times, the core being resaturated before each flood. The flooding was done at pressure gradients from 0.10 to 11.15 p.s.i. per foot. The flooding pressures were not in ascending or descending order but were varied so the direction changed six times. The rate of advance of the flood front varied from 0.16 to 23.8 feet per day. Some rates were considerably slower and others much faster than the average of those considered prevalent in the field in sands of comparable properties. Frequent readings were made so that the point at which the flood water broke through could be determined accurately. Flooding was continued at least until an instantaneous produced water to oil ratio of 100 to 1 was obtained.

The Rushford core was saturated and flooded eight different times at pressure gradients varying from 1.02 to 49.5 p.s.i. per foot .The rate of advance of the flood front for this core varied from 0.04 to 2.32 feet per day, values which cover the average range of the flood rates in the Bradford field through sands of similar properties. As in the case of the Venango core sufficient readings were taken during the progress of the floods to determine the water break-through point and the point representing a produced water to oil ratio of 100 to 1. Due to the small amount of oil produced, the 100 to 1 produced water to oil ratio point for this core was more difficult to determine with accuracy.

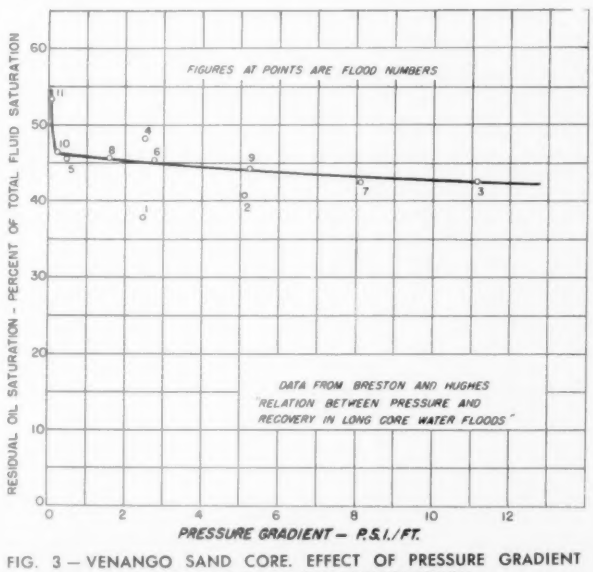

FIG. 3 — VENANGO SAND CORE. EFFECT OF PRESSURE GRADIENT ON RECOVERY TO WATER BREAKTHROUGH.

RESULTS

Venango Core Floods

Data summarizing the results obtained from the eleven floods on the Venango core are found in Table I and illustrated graphically in Figs. 3 to 9. Inasmuch as the core increased in total liquid content with each successive saturation, as illustrated in Fig. 8, the recoveries at the various pressure gradients were based on an effective pore volume equal to the total liquid content at the time. This unintentional change in total fluid saturation and perhaps pore pattern introduces a certain variable which the authors feel can be minimized by calculating recoveries on the effective pore volume basis. Figs. 3 and 4 illustrate the recoveries at the point of water breakthrough and at the 100 to 1 produced water to oil ratio point in terms of residual oil saturation at the various pressure gradients. Discounting the values for floods 1 and 2 because of low total liqiud content and correspondingly high unnatural recovery, the curves show a definite decreased in residual oil saturation at the higher flood pressure gradients. The poor recovery for the very low pressure gradient flood is reflected in the high residual oil saturation.

Since the ratio of oil to water content of the core at the end of each saturation was very nearly the same (except for sat-

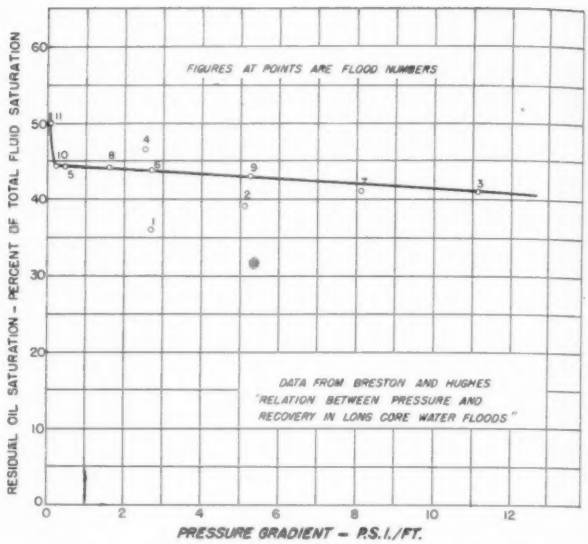

FIG. 4 — VENANGO SAND CORE. EFFECT OF PRESSURE GRADIENT ON RECOVERY UP TO 100 TO 1 PRODUCED WATER TO OIL RATIO.

TABLE 1

Summary — Water Flood First Venango Sand Core

Size: 51" x 4⅛" Permeability: N_2 = 135 md.
Brine = 49 md.

Bulk Vol. = 11,171 cc.

Pore Vol. = 2,011 cc. (From an estimated porosity of 18%)

Operation	Pressure Gradient PSI/ft.	Flood Velocity ft/day	Oil Plus Water at End cc.	Total Oil Content in cc.			Percent Oil Saturation (18 Percent Por., 2011 cc.)			Percent of Initial Oil Content Recovered		Percent of Total Oil Recovered	Oil Satn., Percent of Total Liquid Saturation	
				at Saturation	at Water Breakthru	at w/o ratio of 100:1	at Saturation	at Water Breakthru	at w/o ratio of 100:1	up to Water Breakthru	up to w/o Ratio of 100:1	up to Water Breakthru	at Water Breakthru Breakthru	at w/o Ratio of 100:1
Brine Saturation...			1096.0											
1st Oil Saturation..			1136.5	761.5			37.9							
1st Brine Flood....	2.50	4.9	1129.0		425.5	406.5		21.2	20.2	44.1	46.6	94.6	37.7	36.0
2nd Oil Saturation..			1167.0	827.0			41.1							
2nd Brine Flood....	5.13	11.5	1163.5		471.0	455.0		23.4	22.6	43.1	45.0	95.7	40.5	39.1
3rd Oil Saturation..			1182.5	861.0			42.8							
3rd Brine Flood....	11.15	23.8	1203.0		510.0	493.0		25.4	24.5	40.7	42.7	95.4	42.4	41.0
4th Oil Saturation..			1260.0	930.5			46.3							
4th Brine Flood....	2.54	4.9	1210.5		581.5	565.0		28.9	28.1	37.5	39.3	95.5	48.0	46.7
5th Oil Saturation..			1186.0	914.5			45.5							
5th Brine Flood....	0.48	0.9	1295.0		588.5	577.0		29.3	28.6	35.6	37.1	96.0	45.4	44.4
6th Oil Saturation..			1330.5	982.5			48.9							
6th Brine Flood....	2.70	5.0	1360.0		613.0	597.0		30.5	29.7	37.6	39.2	95.8	45.1	43.9
7th Oil Saturation..			1360.0	991.0			49.3							
7th Brine Flood....	8.13	15.3	1401.0		594.5	576.5		29.6	28.7	40.0	41.8	95.7	42.4	41.1
8th Oil Saturation..			1462.5	1056.5			52.5							
8th Brine Flood....	1.60	2.5	1465.5		667.0	647.5		33.2	32.2	36.9	38.7	95.2	45.5	44.2
9th Oil Saturation..			1449.5	1055.5			52.5							
9th Brine Flood....	5.25	9.2	1477.0		651.5	634.5		32.4	31.6	38.3	39.9	96.0	44.1	43.0
10th Oil Saturation.			1507.0	1078.0			53.6							
10th Brine Flood...	0.22	0.35	1518.0		701.5	677.0		34.9	33.7	34.9	37.2	93.9	46.2	44.6
11th Oil Saturation.			1561.0	1144.0			56.9							
11th Brine Flood...	0.10	0.16	1584.5		842.5	795.5		41.9	39.6	26.3	30.4	86.5	53.2	50.2

urations 1 and 2) another way of interpreting the results whereby the variable of increasing fluid content is greatly eliminated is to plot the recoveries in terms of the per cent of initial oil content. This is shown in Figs. 5 and 6. Fig. 5 illustrates the greater recoveries obtained with increasing pressure gradient and Fig. 6 illustrates the greater recoveries obtained with increasing flood velocity. Inasmuch as there is a direct relationship between pressure gradient and flood velocity a close and expected similarity is shown between the curves of Figs. 5 and 6.

Fig. 7 is introduced to show the accumulative oil recoveries for the eleven Venango core floods when plotted against time. The semi-log scale was used to avoid an extended graph. Curves drawn through the water breakthrough points and the points representing a produced water to oil ratio of 100 to 1 also clearly show the higher recoveries obtained at the higher flooding pressure gradients.

Inferring that one must analyze the results on a basis of total pore volume and not effective pore volume, Fig. 9 was plotted to show that it would not change the interpretation of

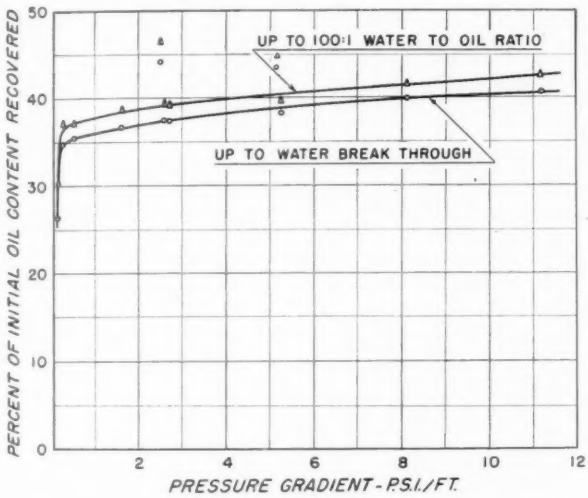

FIG. 5 — GREATER RECOVERIES OBTAINED WITH INCREASING PRESSURE GRADIENT.

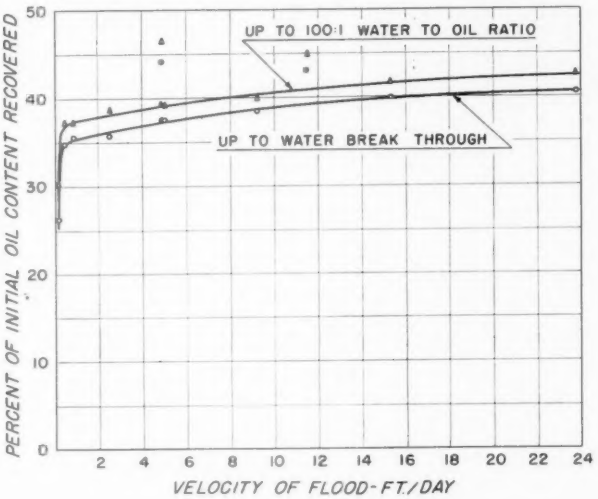

FIG. 6 — GREATER RECOVERIES OBTAINED WITH INCREASING FLOOD VELOCITY.

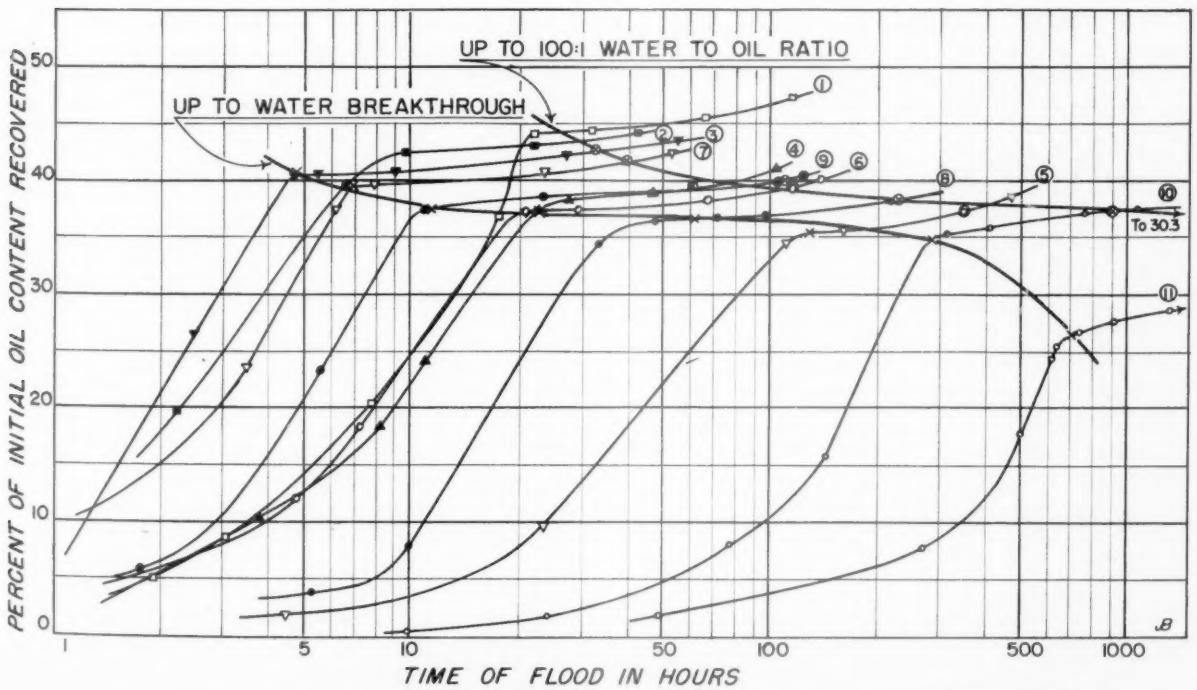

FIG. 7 — ACCUMULATIVE OIL RECOVERIES FOR ELEVEN VENANGO CORE FLOODS WHEN PLOTTED AGAINST TIME

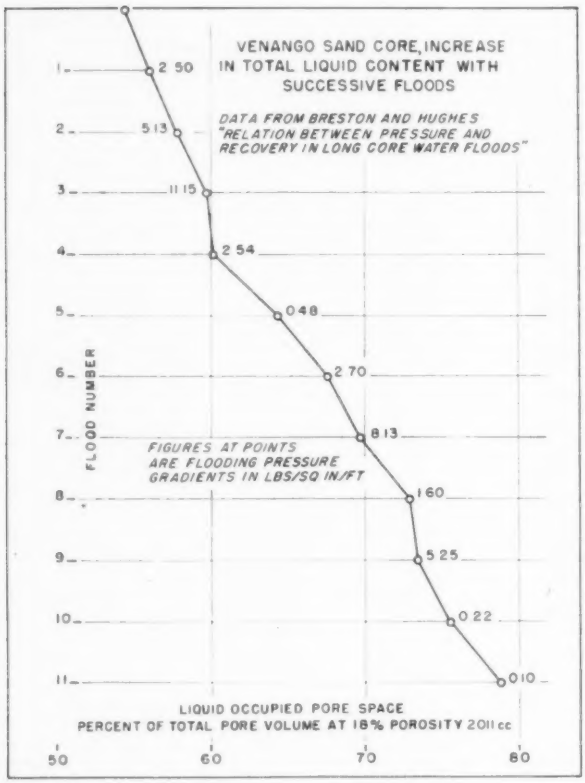

FIG. 8 — INCREASE IN TOTAL LIQUID CONTENT WITH SUCCESSIVE FLOODS

the data. The initial and final oil saturations for the eleven floods are plotted against each other as per cent of total pore volume. The dashed line was drawn through the points representing floods of approximately the same pressure gradient. An examination of the position of the points shows that those representing the high pressure gradient floods fall to the left of the curve and the low pressure gradient flood points fall to the right of the curve. The point for the extremely low pressure gradient flood (0.10 p.s.i./ft.) falls far to the right of the curve. Thus, it is shown that although the trend was to continuously higher residual oil saturation after each flood the effect of the pressure gradient of the flood on recovery and its attendant effect on residual saturation causes a deviation from this trend which is unmistakable.

Rushford Core Floods

The Rushford sand core was selected for similar flooding pressure gradient versus recovery experiments to see if a sand of markedly different characteristics would show the same relationships as indicated by the Venango core floods. The data summarizing the results of eight floods are found in Table II and illustrated graphically in Figs. 10 and 11. Unlike the case of the Venango sand core the total fluid content of this core did not change very much from flood to flood. As a result a direct relationship between pressure gradient and residual oil saturation was obtained as shown in the Figs. As in the case of the Venango core, lower residual saturations are obtained at the higher pressure gradients. The curves plotting per cent of initial oil content recovered versus pressure gradient show the same relationship. Inasmuch as the 100 to 1 produced water to oil ratio point was difficult to determine accurately for the floods on the Rushford core, the curves in Fig. 11 could not be located with certainty.

TABLE II

Summary — Flooding Rushford Sand Core

Size — 12" x 4⅛", Air Permeability 15.3 md., Brine Permeability 2.55 md.

Operation	Pres. Grad. psi/ft.	Flood Veloc. ft./D	Oil Water at end cc.	Total Oil Content at end cc.	Percent of Initial Oil Content Recovered		Residual Oil Saturation Percent of Total Liquid Saturation		Percent of Total Oil Recovered up to Water Breakthrough
					to Water Breakthrough	to 100/1 Water Oil Ratio	to Water Breakthrough	to 100/1 Water Oil Ratio	
Brine Saturation			363.0	0					
1st Oil Saturation			450.5	306.0					
1st Brine Flood	49.5	1.7	425.0	129.5	54.5	57.6	32.7	30.5	94.6
2nd Oil Saturation			460.5	300.5					
2nd Brine Flood	7.0	0.21	449.0	152.0	41.2	48.4	39.3	34.5	85.2
3rd Oil Saturation			490.0	319.0					
3rd Brine Flood	29.0	2.0	488.0	164.0	44.0	47.6	36.6	34.2	92.5
4th Oil Saturation			495.5	314.5					
4th Brine Flood	5.5	0.23	497.5	173.5	37.8	44.8	39.3	34.9	84.4
5th Oil Saturation			490.5	309.5					
5th Brine Flood	19.5	1.00	492.5	154.0	43.0	48.8	36.8	32.2	88.1
6th Oil Saturation			503.0	316.5					
6th Brine Flood	40.2	2.32	495.5	144.0	44.4	53.1	35.5	30.0	83.6
7th Oil Saturation			508.5	320.5					
7th Brine Flood	10.25	0.45	516.5	161.5	42.7	48.6	35.5	31.8	87.9
8th Oil Saturation			542.5	332.5					
8th Brine Flood	1.02	0.04	(542.5)		33.1	39.1	(41.0)	(37.3)	(84.6)

Figures in parentheses are estimated from incomplete flood.

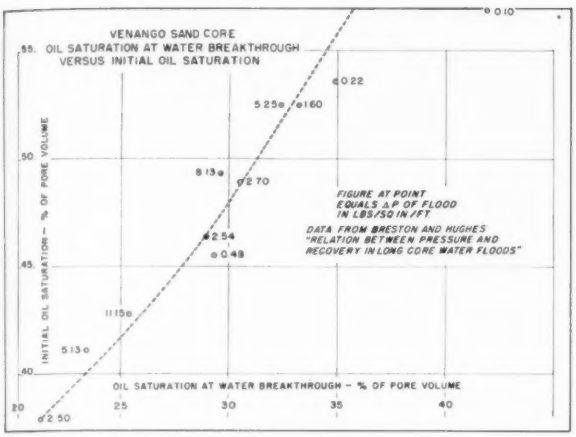
VENANGO SAND CORE
OIL SATURATION AT WATER BREAKTHROUGH VERSUS INITIAL OIL SATURATION
INITIAL OIL SATURATION — % OF PORE VOLUME
OIL SATURATION AT WATER BREAKTHROUGH — % OF PORE VOLUME
FIGURE AT POINT EQUALS ΔP OF FLOOD IN LBS/SQ IN./FT.
DATA FROM BRESTON AND HUGHES "RELATION BETWEEN PRESSURE AND RECOVERY IN LONG CORE WATER FLOODS"

FIG. 9 — OIL SATURATION AT WATER BREAKTHROUGH VS. INITIAL OIL SATURATION

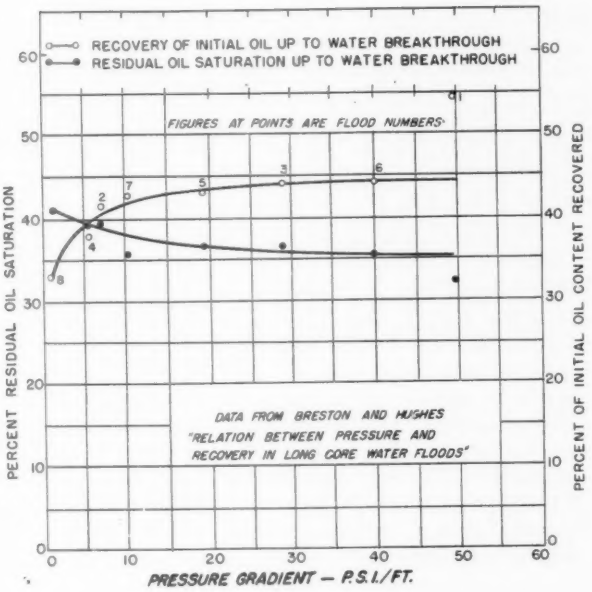
RECOVERY OF INITIAL OIL UP TO WATER BREAKTHROUGH
RESIDUAL OIL SATURATION UP TO WATER BREAKTHROUGH
FIGURES AT POINTS ARE FLOOD NUMBERS
PERCENT RESIDUAL OIL SATURATION
PERCENT OF INITIAL OIL CONTENT RECOVERED
DATA FROM BRESTON AND HUGHES "RELATION BETWEEN PRESSURE AND RECOVERY IN LONG CORE WATER FLOODS"
PRESSURE GRADIENT — P.S.I./FT.

FIG. 10 — RUSHFORD SAND CORE. EFFECT OF PRESSURE GRADIENT ON RECOVERY TO WATER BREAKTHROUGH

GENERAL DISCUSSION

Results of long core water flood research reported upon by Morse and Yuster and by Holmgren are of particular interest with respect to the work described above.

Morse and Yuster[14] also used long cores from the Venango sand of the Franklin, Pa., mine. Some of their floods were started with 100 per cent oil saturations and others with representative percentages of connate water present. Pressure gradients covered those used in the present study. During 42 water floods there was no relationship indicated between flooding pressure gradient and residual saturation. Examination of the data presented by them also fails to show any relationship between flooding pressure gradient and percentage of original saturation recovered.

Fig. 7 shows the accumulative oil recoveries for the eleven Venango core floods plotted against time. The semi-log scale was used to avoid an extended graph. Curves drawn through the water breakthrough points and the points representing a produced water-oil ratio of 100 to 1 clearly show that higher percentages of recovery were obtained at the higher flooding pressure gradients. Holmgren[15] has presented similar accumulative production-time curves for five of his long core water floods at varying pressure gradients. Fig. 12 is a reproduction of his figure with an added curve drawn through what may be assumed to be the water breakthrough points. If Holmgren's first flood is disregarded, the trend of the added curve also indicates higher percentages of recovery with higher flood pressure gradients which is contrary to the preliminary conclusions stated in his paper. The recovery obtained from his first flood may have been abnormally high and analagous to those obtained during the first two floods with the Venango core and the first flood with the Rushford core.

Past practices of plotting residual saturation against flooding pressure gradient may have caused conflicting interpretations of recovery versus pressure gradient because the cores were

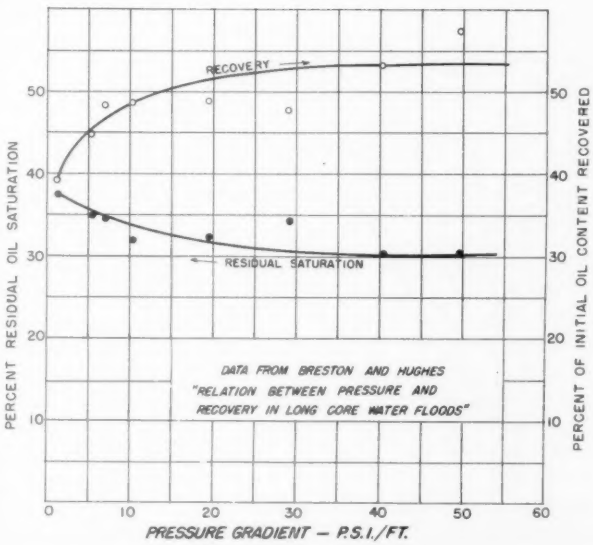
RECOVERY
RESIDUAL SATURATION
PERCENT RESIDUAL OIL SATURATION
PERCENT OF INITIAL OIL CONTENT RECOVERED
DATA FROM BRESTON AND HUGHES "RELATION BETWEEN PRESSURE AND RECOVERY IN LONG CORE WATER FLOODS"
PRESSURE GRADIENT — P.S.I./FT.

FIG. 11 — RUSHFORD SAND CORE. EFFECT OF PRESSURE GRADIENT ON RECOVERY UP TO 100 TO 1 PRODUCED WATER TO OIL RATIO

flooded only once before extraction and resaturation. It has been noted in the case of the Venango core that abnormally high recoveries were obtained on the first and seocnd floods. Recovery from the first flood was greater than for the sceond even though the initial oil saturation of the core was less the first time. This indicates that the oil injected into the core during the first and second saturations penetrated only into the larger and more accessible pores from which it could be most easily flooded by the subsequent brine floods. Further saturation or additional saturations under pressure would be expected to force more of the oil and/or water into the smaller pores where it is logical to expect the effect of pressure gradients upon recoveries to be more pronounced.

As concluded by Earlougher[32] there apparently is a relationship between the relative amount of oil and water and its distribution within the sand and the amount that can be recovered by water flooding at a given pressure gradient. The distribution of the oil content of the sand both prior to and after water flooding is chiefly a function of the relative size and distribution of the pore restrictions. The smaller the restrictions the greater the pressure gradient necessary both to saturate all such pores and to flood contained oil from them.

SUMMARY AND CONCLUSIONS

Nineteen laboratory floods on two long, consolidated sand cores were conducted to determine the effect of pressure gradient and/or flood velocity on oil recovery. In an attempt to simulate flood conditions as closely as possible, the same pressure gradients and flood velocities covering the ranges considered normally occuring in field operations were used. Also, a live natural crude was used for saturating the cores, as well as a natural brine for connate water content and for flooding. With the exception of the first three floods conducted a definite relationship between flooding pressure gradient and recovery has been shown in that higher flooding pressure gradients have given higher recoveries and lower residual oil saturations. As velocity is a direct function of pressure gradient, it has been shown also that higher rates of flooding resulted in higher percentages of recovered oil. Very low pressure gradients and flooding velocities resulted in markedly low recoveries.

The observations made during and as a result of these flooding experiments are not to be interpreted that every type of sand which can be water flooded will produce the maximum yield of oil at high pressure gradients. There may very well be an optimum pressure for many sands depending upon their physical and chemical characteristics and upon the ratio and mode of distribution of their water and hydrocarbon content. Proper pressure gradients for field use are still difficult to predict.

ACKNOWLEDGMENTS

These water flooding experiments were carried out as part of the overall secondary recovery research program of the Pennsylvania Grade Crude Oil Association in its laboratory at

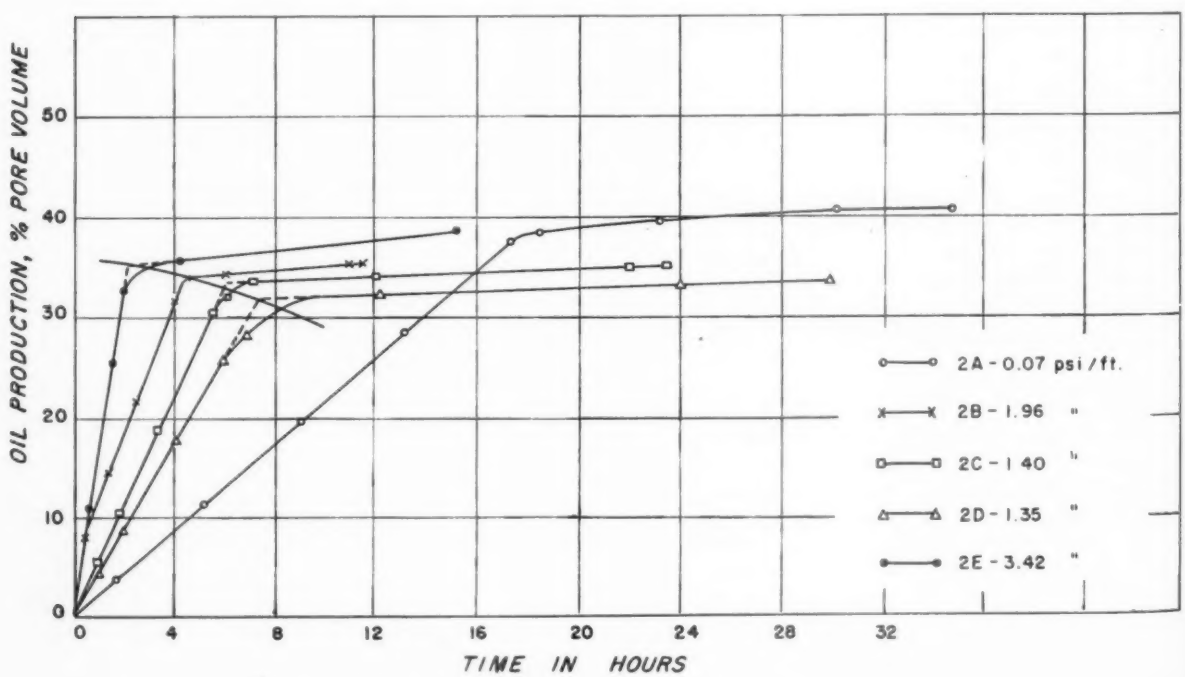

FIG. 12 — WATER DRIVE EXPERIMENTS, GROUP II (FROM HOLMGREN)

Bradford, Pa. The authors wish to express their appreciation and thanks to the many individuals and staff members who have aided in or otherwise made possible the conducting of these experiments. Particular thanks are due to Dr. R. J. Pfister, who formerly directed the Association's laboratory research, and to Willard Johnson, who ably assisted at all times during the experiments.

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DISCUSSION

By Harry M. Ryder, Consulting Engineer, Washington, D. C.

The problem attacked by the authors is of greatest fundamental importance to petroleum reservoir engineers. In work of this type, the simulation of field conditions is very important. The effort on the part of the authors is commendable but the extent to which simulation was in fact achieved is not evaluated. The old oil in both cores had been exposed to oxidation for extended periods prior to their use for the experimental work. The presence of oxidized organic material can affect interfacial conditions and may or may not have appreciably influenced the water-flood characteristics. The mean pressures used were very much lower than those usual in the field.

The percentage of the initial oil content recovered is not necessarily a measure of the effectivenes of a water drive. Extensive field observations at Bradford have provided no indication that the residual oil saturation is a function of the initial oil saturation. A flood which will leave 25 per cent of the pore space occupied with oil is equally effective whether the initial oil content is 90 per cent or 40 per cent of the pore space, but the per cent of the oil removed in the former case is far greater than in the latter. The residual oil saturation as per cent of pore space is the fairest criterion of flood effectiveness.

After the first two runs, the pore-filling behavior in the Rushford-sand core was much better than in the case of the Venango sand. In Fig. 1 the residual oil saturation is plotted

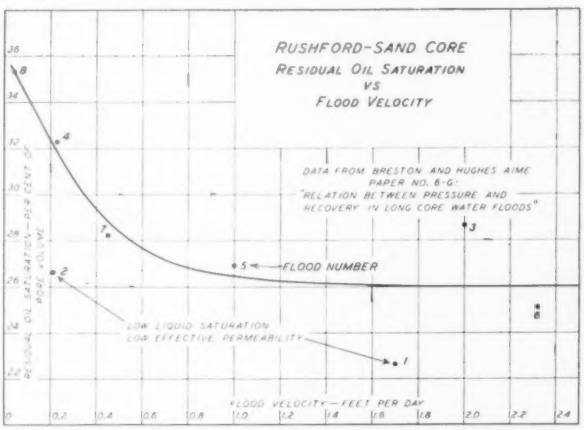

FIG. 1 — RUSHFORD SAND CORE, RESIDUAL OIL SATURATION VS. FLOOD VELOCITY.

directly against flood velocity. Disregarding the first two floods because of low total liquid content and corresponding low effective permeability, this curve strongly suggests an economically important increase in flood effectiveness with increasing velocity up to about one foot per day and under the circumstances of the investigation. A theory as to why this should be so has been reported.[1] The potential economic importance of this relation may the better be understood when it is realized that a large part of the Bradford field oil is produced as a result of flooding at a velocity of less than three inches per day, only a small part being produced at a velocity in excess of one foot per day.

Whether pressure or velocity in fact exercises a dominant control over residual oil saturation, and hence over flood effec-

tiveness, other factors being constant, can be determined only by comparative flood tests. For such tests, several long cores should be used, identical in every respect except for different permeabilities. The authors could contribute to this knowledge by flooding additional Rushford-sand cores of different permeabilities.

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Author's reply to Harry M. Ryder

The authors greatly appreciate Ryder's remarks and his added analysis of the data reported.

We were aware of the fact that the presence of oxidized organic material may affect interfacial conditions and perhaps appreciably influence the water-flood characteristics. In order to eliminate or minimize such a possibility the cores were well "flushed" by flowing through under pressure a goodly number of pore volumes of fresh, live crude before completing the first saturation. The first portion of the effluent crude was dark and viscous showing that much of the oxidized organic material was being removed.

Due to the pressure limitations of the apparatus the mean absolute pressures used were lower than those usual in the field. However, since the experiments were conducted on a basis of 100 per cent fluid saturation; i.e., no free gas, it was only necessary to maintain a pressure slightly in excess of the bubble point of the saturating crude. The pressure gradients used did cover the range common in the field.

Since the cores were saturated each time to the same water-oil ratio content, calculating the recoveries as percentage of the initial oil content automatically corrected for the changing total fluid content. It is the same as calculating the effectiveness of the water floods on a basis of residual oil saturation as per cent of effective pore volume if the effective pore volume is considered to be equal to the total fluid saturation at the time. ★ ★ ★

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